MARCH 1960

Agricultural Engineering

The Journal of the American Society of Agricultural Engineers

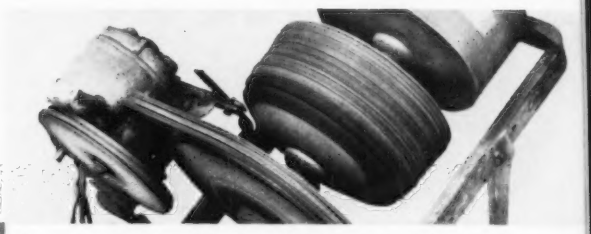
Accelerated Testing of Farm Machinery | 154

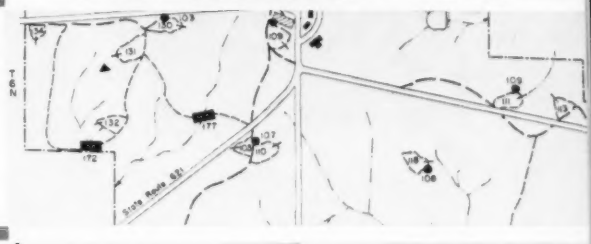
Effect of Land Use on Stream Flow | 158

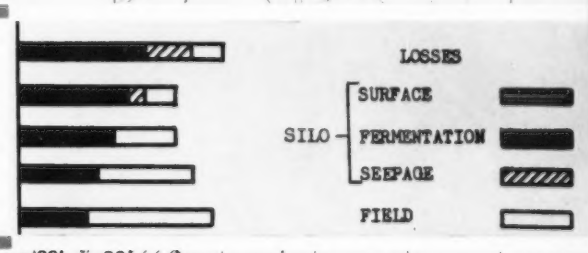
Storing and Feeding Silage | 162

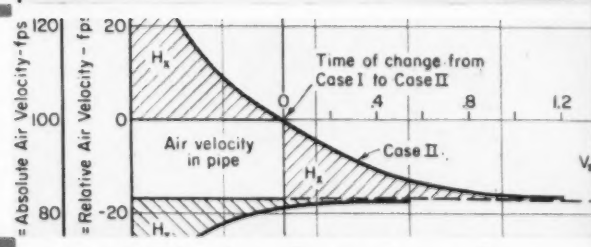
Air and Solid Particles in a Vertical Pipe | 168

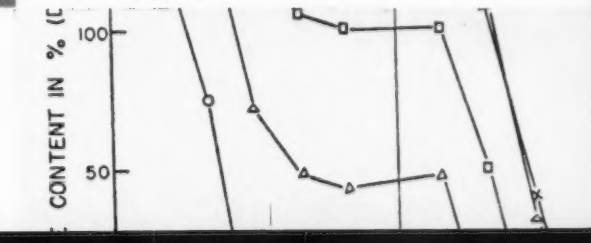
Hay-in-a-Day Harvesting | 172











CASE HISTORIES

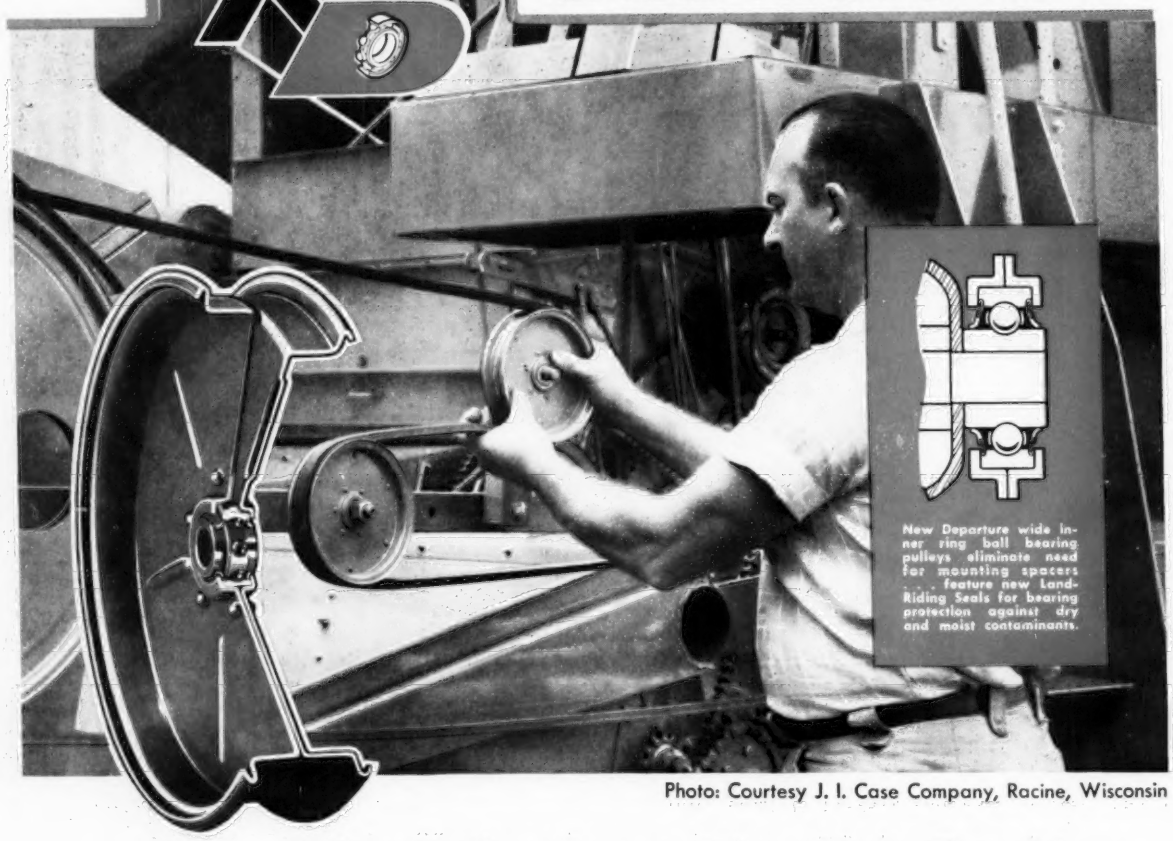

New Departure wide inner ring ball bearing pulleys eliminate need for mounting spacers . . . feature new Land-Riding Seals for bearing protection against dry and moist contaminants.

Photo: Courtesy J. I. Case Company, Racine, Wisconsin

Idler Pulley Assemblies Help Combine Manufacturer Cut Inventory & Assembly Costs!

CUSTOMER PROBLEM:
Leading farm implement manufacturer experiencing rising costs in the installation of ball bearing pulleys on combines and other farm implements.

SOLUTION:
N/D Sales Engineer, in cooperation with the manufacturer, made an evaluation of pulley applications. He then recommended N/D Land-Riding Seal pulley assemblies containing ball bearings with *wide* inner rings. The wide inner ring paved the way to cutting costs by eliminating conventional spacer inventories. Moreover, the manufacturer now enjoys additional savings because N/D Lubricated-for-Life ball bearing pulleys are *fully assembled* at delivery . . . simplifying inventory even more!

The wide inner ring bearing, butt mounted rigidly against face plate, requires a minimum of parts handling and adjusting at assembly. In addition, these 8" O.D. pulleys have rolled sheave edges for belt protection. All pulleys come with the new and exclusive N/D Land-Riding Seals, factory greased, ready to offer full maintenance-free protection against dry and moist contaminants.

If *you're* a user of flat and "B" section V-Belt pulleys, sizes from 2¾" to 8" O.D., why not check on the savings N/D has to offer? Contact your local N/D Sales Engineer or, write today for the new N/D Idler Pulley Bulletin giving complete specifications and mounting data. New Departure Division, General Motors Corp., Bristol, Conn.

Replacement pulleys available through United Motors System and its Authorized Bearing Distributors.

NEW DEPARTURE
BALL BEARINGS
proved reliability you can build around

Another JOHN DEERE Implement Uses...

BLOOD BROTHERS
Jointed Drive Assemblies

A forage harvester that large-acreage growers will find ideal for their heavy-duty operations is the new John Deere "12." It combines versatility, big capacity, and dependability. Its six or seven-foot mower bar covers the acres with speedy precision. The basic machine is readily adapted for harvesting standing or windrowed hay crops and row crops.

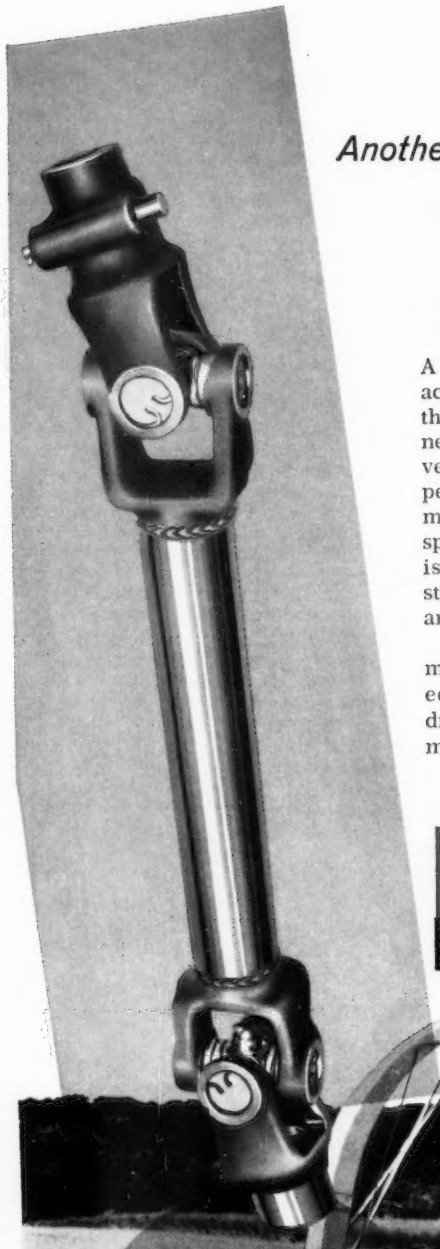
This new unit, like many other most advanced farm implements, is equipped with a Blood Brothers drive line. Blood Brothers met the manufacturer's specifications exactly with an assembly from tractor P.T.O. to gear box. It is typical of the many drive assemblies Blood Brothers furnish for both specialized and conventional farm implements.

You save time and money – and get the best drive components made–when you consult Rockwell-Standard engineers for the solution to any power transmission problem. A letter or phone call will bring cooperative, friendly, experienced assistance.

For complete information, write for Bulletin.

Another Product of...

ROCKWELL-STANDARD
CORPORATION
Universal Joint Division, Allegan, Michigan



New John Deere 12 Forage Harvester

Agricultural Engineering

Established 1920

CONTENTS • MARCH, 1960 • Vol. 41, No. 3

Report to Readers 134

Changes in Education in Relation to Agricultural Engineering 153
L. E. Grinter

Accelerated Testing of Farm Machinery 154
Arnold B. Skromme

Evaluating Effect of Land Use on Stream Flow 158
D. L. Brakensiek and C. R. Amerman

Equipment and Labor Requirements for Storing and Feeding Silage 162
A. T. Hendrix

Relations Between Air and Solid Particles Moving Upward in c Vertical Pipe 168
William J. Chancellor

Hay-in-a-Day Harvesting 172
Thomas T. Pedersen and Wesley F. Buchele

Technical Paper Abstracts 179

News Section 180

ASAE Members in the News 182

With the ASAE Sections 184

New Products 186

New Books 190

New Bulletins 191

Manufacturers' Literature 192

Research Notes 196

Personnel Service Bulletin 198

Index to Advertisers 200

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Blue-Green Color Blind?

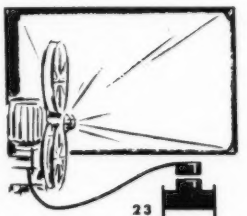
THOSE of our readers who find difficulty in distinguishing between colors such as blue and green may be thoroughly confused if they are of the opinion that since covers for previous February issues are blue, it is most certain that the February 1960 issue cover is also blue. We must confess that the switch from blue to green this year was not done intentionally, and likewise we did not investigate to see if the pressman who inked the roller is color blind. All we can say is that an unaccountable error occurred and that the regular color scheme will be followed for the remainder of the year. It is hoped that this reached you before you checked with your doctor to see if you really are color blind.

Committee to Hold Workshop Meeting

THE Technical Committee of the Power and Machinery Division of ASAE has arranged for a series of Workshop Meetings for the Committee and its various subcommittees, to be held at the Whitcomb Sulphur Springs Hotel in St. Joseph, Mich., on May 3 and 4. It is the opinion of the Committee that a Workshop Meeting would permit more time for the Technical Committee to fulfill its responsibilities of formulating and approving ASAE Standards than is possible during national ASAE meetings. It is felt, also, that a joint meeting of this type would result in closer coordination between the Committee and its subcommittees.

The first day will be devoted to subcommittee activities to finalize any unfinished business. On the second day the Technical Committee will receive reports from all subcommittees and will devote an entire day to new and unfinished business.

Availability of excellent meeting facilities and the recent inauguration of air service aided in the selection of St. Joseph for the meeting. A tour of ASAE headquarters, to better acquaint members with headquarters facilities, is being planned for Tuesday morning, May 3. In addition, tours of local industries are being arranged. Other committees interested in conducting similar meetings, especially those who would like to meet at ASAE headquarters or in St. Joseph, may contact J. L. Butt for further details.

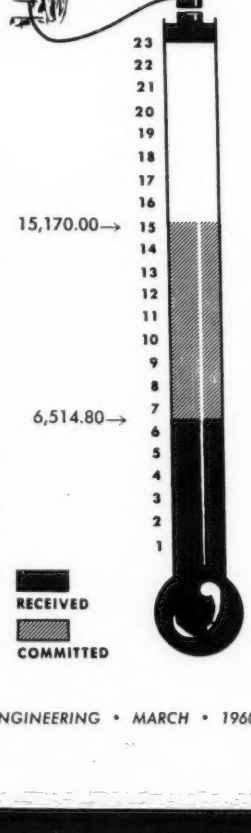


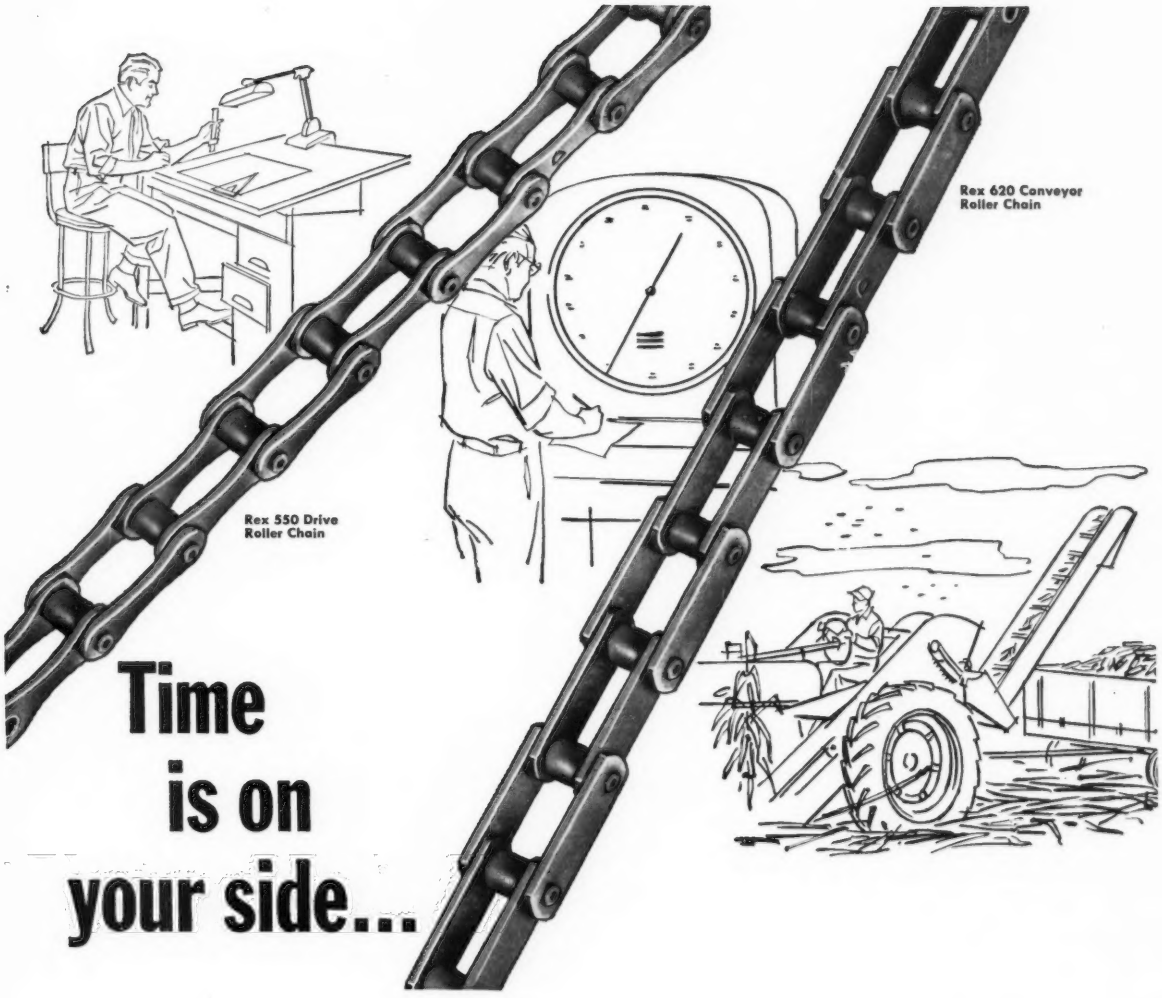
ASAE Motion Picture Report

DURING the month of February cash received for the ASAE Motion Picture Fund amounted to $400.44. Commitments have been increased by $50.00, or equal to cash received during the month from individuals, bringing the total to $15,170.00. Contributions from individuals and payments from the North Atlantic and Southeast Sections increased the total cash received to $6,514.80.

The number of paid up Sections now totals 22, of which 10 have oversubscribed. Also 27 copies of the film have been ordered by colleges, surpassing the expected quota by $1,750.00.

Watch this column each month to observe the progress of the motion picture project.





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when you specify Rex 550 and 620 Roller Chains

Time is of the greatest importance to you. The years we've spent in designing, testing and applying these chains not only can save you money, but can make the big difference in the performance of your equipment. Here's how:

First, Rex 550 and 620 Chains were developed specifically to help solve your design problems demanding greater strength and efficiency than you could get with detachable chains. They fit the same sprockets as Nos. 55 and 62 detachable chains, but they are *true roller chains.* They have Rex quality built in, but they are still low in cost.

Second, these are field-proven chains. No need for you to gamble your reputation or that of your equipment on untested chains which may fail and cause trouble. For full information on Rex 550 and 620 Roller Chains and attachments, contact your local CHAIN Belt District Office.

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AGRICULTURAL IMPLEMENT CHAINS

HIGH-REDUCTION BEVEL GEARS

To the nine gear types* already made by us for a long list of leading manufacturers, we now add High-Reduction Bevel Gears to meet a growing demand for the economy and speed reduction accomplished by this type of power transmission.

These DOUBLE DIAMOND High-Reduction Bevel Gears will supply speed reduction normally considered impractical in a single gear set of this type. In many cases they will replace more complex and more costly gear systems, thus improving design and achieving simplicity, while considerably lowering costs.

One of our gear engineers would be more than pleased to meet with you to discuss fully the interesting possibilities of this new member of the DOUBLE DIAMOND family.

EATON

AUTOMOTIVE GEAR DIVISION
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GEARS FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

*Angular bevel gears, Helical gears, Spur gears, Flywheel ring gears, Hypoid bevel gears, Straight bevel gears, Spline shafts, Zerol† bevel gears, Spiral bevel gears. Also gear assemblies.

†REG. U.S. PAT. OFF.

Gadget-free IH balers tie top tonnage without shattering leaves or choking!

Before you count to 10, this speedy IH baler can pick up, pack, and pop out a brick-square bale of hay!

It's simple! There are no beaters . . . no complicated hayforks to shatter and rub off feed-rich leaves. And the big IH bale chamber door ends plug-ups caused by funnel-down feeding. This stops costly leaf loss and keeps you baling non-stop in heavy hay.

Watch how gently . . . how easily a McCormick baler ties a ton of hay every six minutes. Low pick-up raises the windrow into the baler *intact*—like a green carpet! Instantly the full-floating, short auger whisks this stream of hay to the big bale chamber door. Three packer fingers spread it evenly across the bale chamber. Then the plunger packs it firm.

Rubber-roll conditioner saves leaves . . . halves curing time by cracking each hay stem along its *full* length. Now, teamed with a high-speed mower, this McCormick® No. 2 Hay Conditioner lets you crush and mow at the same time.

Get cash for dealing now! Your IH dealer will pay interest at the rate of 6% on your trade-in and/or down payment. Stop in today and ask him for a demonstration. See how high-speed IH hay machines can help you make better hay faster.

The sooner you trade the more you save

See your INTERNATIONAL HARVESTER dealer

International Harvester Products *pay for themselves in use*—Farm Tractors and Equipment . . . Twine . . . Industrial Tractors . . . Motor Trucks . . . Construction Equipment—General Office, Chicago 1, Illinois

Report to Readers . . .

SILOS DEVELOP MARKETS FOR MECHANIZED FARM EQUIPMENT

A Michigan SU economist reports that in the past four years silage-storage capacity on Michigan farms has increased 40 percent. Accompanying this increase has been larger investments by farmers in such labor-saving devices as mechanical wagon unloaders, wagons and feeders. Expanding operations, higher labor costs, and the desire to eliminate the drudgery of feeding and livestock chores are the main reasons for this trend. . . . . It is estimated that a loose-housing system can be mechanized to feed forage to a 60-cow herd in one hour each day - also, that a fully mechanized feedlot can be operated for around $500 a year. Equipment for 100 cows, it is believed, would most likely increase this figure another 40 percent. . . . . For an investment of $6500, it is estimated that such labor savers would provide a good system for feeding 200 steers. Once installed they can be operated for about $3 a month for electric current. . . . . The MSU economist also advised the construction of a concrete feeding floor of 100 square feet per animal, to facilitate the installation and use of mechanized feeding systems. It is estimated that such floors can be built for 18 to 25 cents per square foot.

ONE MAN HANDLES CITRUS FRUIT FROM ORCHARD TO PACKING HOUSE

An agricultural engineer-economist research team at the University of California has come up with a significant new development for getting citrus fruit from orchard to packing house. This one-man handling method uses new light-weight bins made of fiber molded into round nesting drums, each of which holds a little over 200 pounds. . . . . The handling equipment consists of a tractor with a boom hoist mounted at the rear and pulling a trailer. The operator stands on a platform at the rear of the tractor, from which position he drives the tractor and operates the boom to lift the bins of fruit from the ground and set them on the trailer. . . . . A roller bed enables the operator to push the stacks of bins to the back end of the trailer. Also, detents built into the roller frames and into the superstructure hold each stack of bins in place. . . . . The essential new element in this method is in the use of manpower. The tractor boom, the roller floor, and the trailer superstructure are all simple mechanical concepts. The particular importance of this development is that the mechanical features are combined in an arrangement whereby one man can drive the tractor and, from the same position, distribute the empty bins, pick them up when filled, and place them on the trailer easily and speedily.

PLASTIC MOLE-TYPE DRAINS UNDER ENGINEERING STUDY

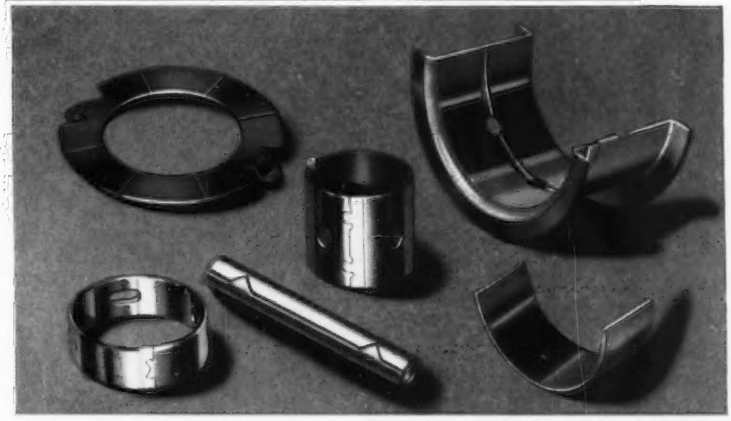
A USDA (ARS) agricultural engineer is conducting cooperative federal-state-industry experiments in the western US to study the efficiency of mole drains lined with low-cost vinyl plastic for draining unused water and crop-damaging salt from cropland. Over a two-year period, similar drains performed well in eastern US, without cave-ins, filling or blockage. So far the findings indicate plastic to be less expensive than conventional tile for removing water and salt from farm land. . . . . In one of the western experiments, in which the outflow from each of five plastic-lined mole drains was about 2½ gpm, the drains were also removing 117 lb of salt a day from a plot of almost 1½ acres. Water drained from the test area contained ten times as much salt as water applied. . . . . Cost of the 15-mil plastic used in the tests was less than ten cents a foot. The plastic drain can be installed at low cost, largely because the digging and refilling of large ditches is unnecessary. . . . . The plastic lining is installed in one continuous operation by a special device developed and loaned by an industry cooperator. This laying device removes the 11-inch-wide plastic from a roll and forms the material into a plastic drain in the soil.

(Continued on page 136)

75-MILLIONTHS OF AN INCH BARRIER HALTS METAL MIGRATION

JUST BENEATH THE FRESH OVERPLATE OF THESE F-M ENGINE BEARINGS (LEFT) LIES A TENUOUS DIFFUSION BARRIER. Though this film of metal is only 75-millionths of an inch thin, it stops tin in the overplate from migrating into the lining metal beneath. Its presence is important to bearing overplate performance, particularly during the critical period of engine break-in. Maintaining uniform thinness as well as uniform composition of the plated barrier is most important . . . and most difficult to achieve on a production scale. Federal-Mogul research has developed a unique, extraordinarily precise method for controlling both the thinness and the metallic composition of this barrier, within narrow limits. And the performance of F-M engine sleeve bearings attests to the success of the method!

RESEARCH INTO ELECTROPLATING problems is a continuing project in the F-M laboratories. Unusual precision equipment and facilities are employed, many of which have been specially designed and engineered by F-M to solve problems of sliding-bearing application. As a result, Federal-Mogul engineered sleeve bearings, precision thrust washers, formed bushings, and low-cost spacers provide the finest possible performance characteristics for any application.



Have you a problem with bearings, bushings or washers? Are you considering the development or redesign of an item of the type shown above? We'll be glad to show you how the job can be done most effectively and economically. For information, write Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc., 11081 Shoemaker, Detroit 13, Michigan.

FEDERAL-MOGUL

sleeve bearings
bushings-spacers
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AG ENGINEERS IMPROVE HANDLING OF THE MULTIMILLION DOLLAR SMALL-SEED CROP

For about ten years USDA (ARS) agricultural engineers and Oregon AES researchers have been intensively searching out better ways to handle the $200 million worth of grass and legume seed produced in the US each year. Here are some of the developments resulting from this worth-while study: (a) Reduction of shatter losses of bird's-foot trefoil 35 percent by combining the crop in windrows on wide sheets of plastic, (b) use by farmers of a moisture meter to tell when grass and legume crops are prime for harvest, (c) "fluidized" conveyor for seed-processing plants to move seed pneumatically at low velocity, (d) precision electrostatic devices to permit additional separations, (e) combination modified-indent cylinder and vacuum system to effectively separate alfalfa and tiny pigweed seeds, (f) automatic seed separator consisting of 8x10-inch vibrating table to enable separations heretofore impossible, and (g) an experimental one-story farm seed-cleaning plant to continuously separate seed by size, surface texture, length, specific gravity, and other characteristics.

EVALUATION OF LOW-COST SOLAR HEAT COLLECTORS

Over a 3-year period USDA (ARS) agricultural engineers have been conducting design tests of low-cost solar heat collectors, in cooperation with the Georgia (college) agricultural experiment station. These tests were to determine what heat collector materials will give maximum efficiency in heating air for drying grain or similar uses. . . . . Sheet metal, either flat or corrugated and painted dull black, proved quite satisfactory. . . . . Four plastic cover sheet materials were tested, but only one proved satisfactory. Polyethylene sagged excessively and could not withstand the heat for the full crop-drying season. Styrene acrylonitrite lasted only one or two weeks before cracking to the extent of becoming worthless. Polyvinylchloride withstood direct exposure to the sun, but sagged to such an extent as to become inferior mechanically. Cellulose acetate butyrate did not deteriorate under direct exposure to sun over a two-year period, and it remained sufficiently rigid to make it mechanically desirable as a cover material. It possessed the best radiation transmission qualities of the four plastic materials tested.

ASPHALT-COATED BURLAP FOR LINING IRRIGATION CANALS

A USDA soil scientist reports good results from early tests of a prefabricated liner for irrigation canals and reservoirs. This liner is 15-ounce burlap coated with asphalt, which appears to be practical and durable. . . . . The burlap, first chemically treated to inhibit rotting, was coated on each side with asphalt, producing a thickness of 3/8 inch. These asphalt-burlap sheets were then laid directly on the soil in the irrigation canals, the edges overlapped, and the joints sealed with a torch. A thin layer of clay was sprayed like paint over the exposed material to retard deterioration of the asphalt. . . . . The exposed liners require half as much excavation as buried liners and are more easily inspected and repaired. The asphalt-burlap liners are expected to cost about $1.00 a square yard, which could be lower than for concrete linings.

BOXED-IN NAILING GIRTS ADD STRENGTH TO BUILDING WALLS

A USDA Forest Service research engineer has made an important discovery for adding strength to grain storage or other building walls that may be put under heavy pressure. This is accomplished simply by boxing in of nailing girts, thereby virtually creating beams. . . . . This engineer found that girts boxed in with one-inch covering boards carried only about one-half as much load as girts that had been covered with 3/8-inch plywood. Also, by concentrating the nails near the ends of the covering boards, the strength and stiffness of the beams was increased, as compared to those with uniform nail spacing.

TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

One in a series of technical reports by Bower

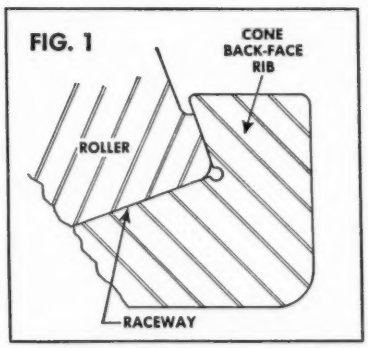
BEARING BRIEFINGS

BEARING GEOMETRY MAKES OR BREAKS BEARING PERFORMANCE

To develop high capacity and optimum performance in a tapered roller bearing, it is essential that roller alignment be accurate. Correct roller alignment, in turn, depends on a critical geometric relationship between the cone back-face rib, and the cone raceway.

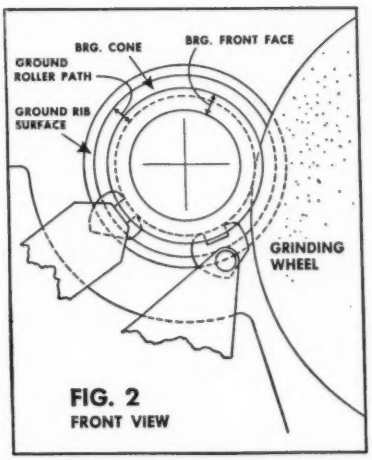
Perfection in this geometric relationship compels the rollers to align themselves perfectly with respect to the bearing geometry, and each roller shares equally in the work that is imposed. Figure 1 diagrams the important elements involved.

When this rib-to-raceway relationship is incorrect (because of either faulty bearing design or manufacturing inaccuracies), rollers experience misalignment and begin to skid and skew under



load. As engineers know, poor performance and premature bearing failure are inevitable under these conditions.

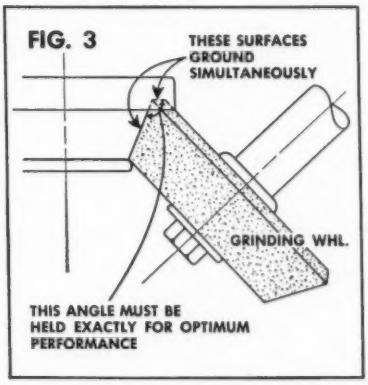
In the design and manufacture of Bower tapered roller bearings, Bower engineers take great care to generate and hold an exact face angle on the cone back-face rib. In practice, this means that Bower



bearings are designed for maximum life and optimum performance under any operating conditions. It means that Bower bearings retain accurate roller alignment under all speeds and loads up to the maximum for which the bearing is rated.

It's one thing to develop proper bearing design on paper, but quite another to carry it out consistently in manufacture. To this end, Bower engineers were instrumental in the design and development of a unique centerless grinder on which Bower precision grinds each bearing's cone raceway and rib-face simultaneously. The results obtained from these machines invariably meet or surpass Bower's exacting requirements and assure perfect roller alignment.

Figures 2 and 3 are front and top views which illustrate Bower's technique of centerless grinding rib-faces and cone raceways together. As a result, every component in a Bower bearing is perfectly concentric about its rolling axis.

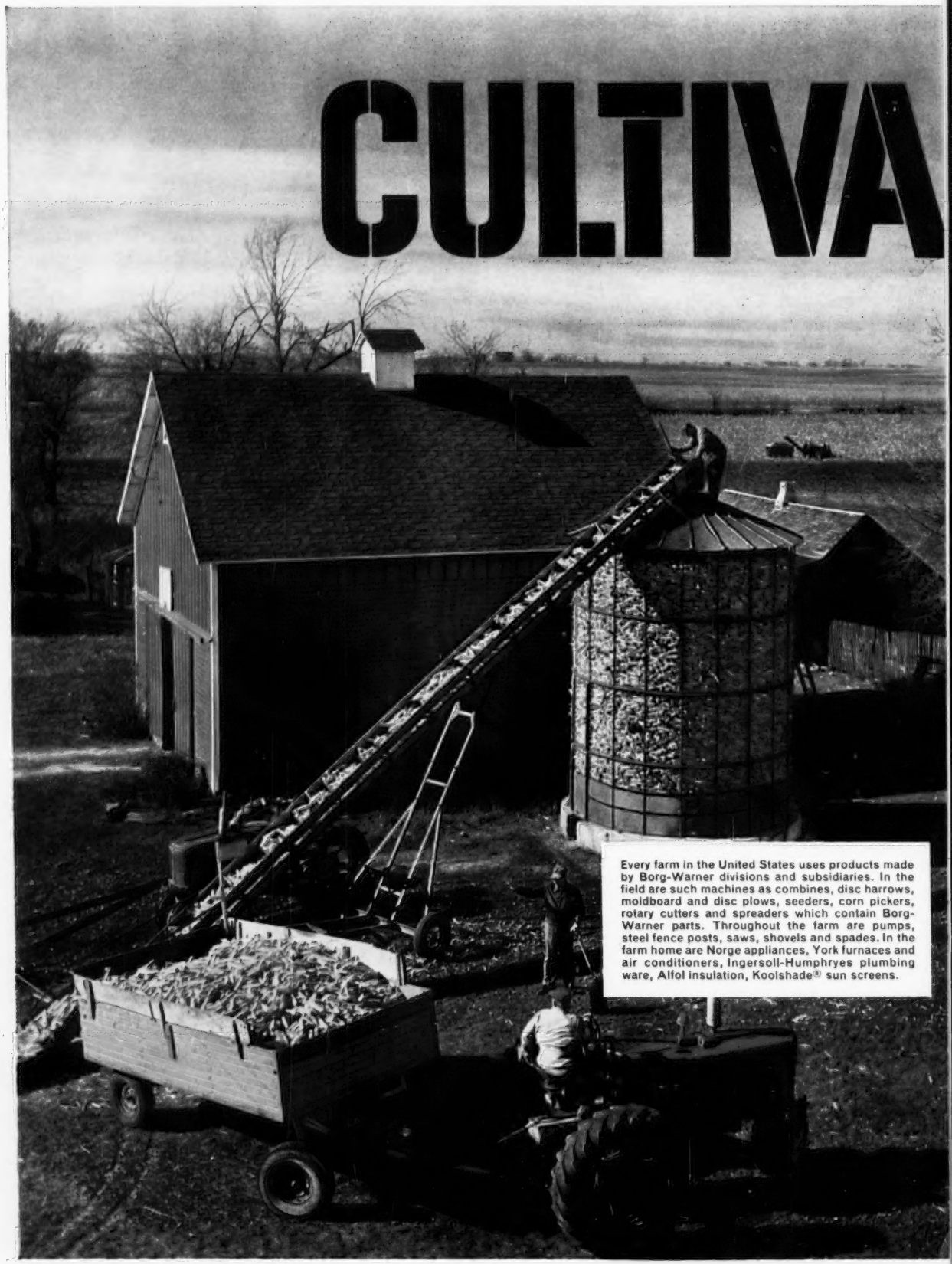


★ ★ ★ ★

When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION — FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN



Every farm in the United States uses products made by Borg-Warner divisions and subsidiaries. In the field are such machines as combines, disc harrows, moldboard and disc plows, seeders, corn pickers, rotary cutters and spreaders which contain Borg-Warner parts. Throughout the farm are pumps, steel fence posts, saws, shovels and spades. In the farm home are Norge appliances, York furnaces and air conditioners, Ingersoll-Humphryes plumbing ware, Alfol insulation, Koolshade® sun screens.

TION

AND HARVESTING
BY BORG-WARNER

A review of the roles which a versatile corporation plays in helping the farmer plant and harvest his crops

This is a Mechanized Age down on the farm—a time of automatic corn-crib loading, of tractors with tremendous lugging power, of deserts-turned-cotton fields through irrigation. And Borg-Warner has played no small part in helping the farmer achieve his present-day efficiency.

Ever since first making disc blades for walking plows in 1884, Borg-Warner has blazed a trail (and a name for itself) in agricultural equipment—such as hydraulic pumps and valves, impact-resistant plow discs, high-speed chain drives. You might say we pioneered our way into becoming one of today's most important part-suppliers to makers of tractors and harrows and balers and harvesters.

At our large and modern Roy C. Ingersoll Research Center in Des Plaines, Illinois, we're actively engaged in the "tomorrow." There, we're devoting time and imagination to projects designed to bring even greater efficiency to farming.

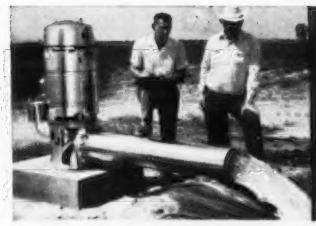
The products of Borg-Warner Corporation fall into seven categories. Farm equipment is one. Oil, steel and chemicals is another. Industrial machinery, still another. Of course, our name is readily associated with automotive parts and home equipment. We are, in addition, a leader in making parts for the aviation, missile and rocket industries and for national defense. All in all, Borg-Warner makes hundreds of products with thousands of uses for the benefit of millions.

B-W

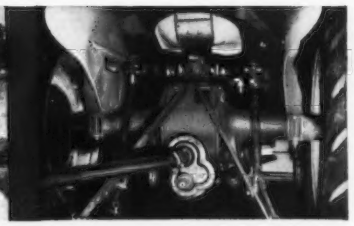
BORG-WARNER

200 South Michigan Avenue • Chicago 4, Illinois

It's a better product when Borg-Warner makes it



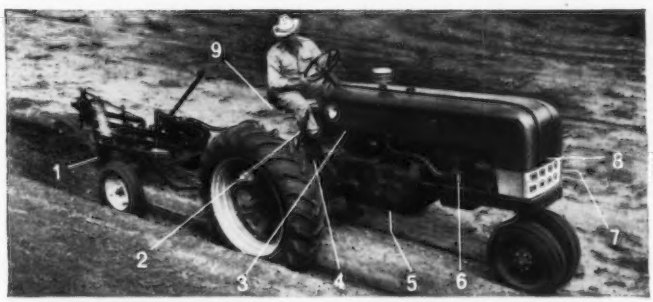
HEART OF IRRIGATION SYSTEM is the deepwell turbine pump above—designed and produced by the Byron Jackson Division—one in a broad line of pumps to answer irrigation needs, large or small, at home and abroad.



SAVES TIME AND LABOR: New power take-off adapter by the Warner Automotive Division fits any tractor, operates implements at 540 and 1000 rpm, eliminates separate power take-off for implements of different speeds.

UP GOES ANOTHER FENCE of Gold Crown Steel Posts, whose exclusive shrunk-on anchor plates are guaranteed not to come off, made by Calumet and Franklin Steel Divisions.

75 YEARS OF EXPERIENCE stand behind leadership of Ingersoll Products Division in implement discs and coulter blades. Today's models, of specially heat-treated cross-rolled steel, have punched out angle notches and keep pace with speed and power of modern tractors.

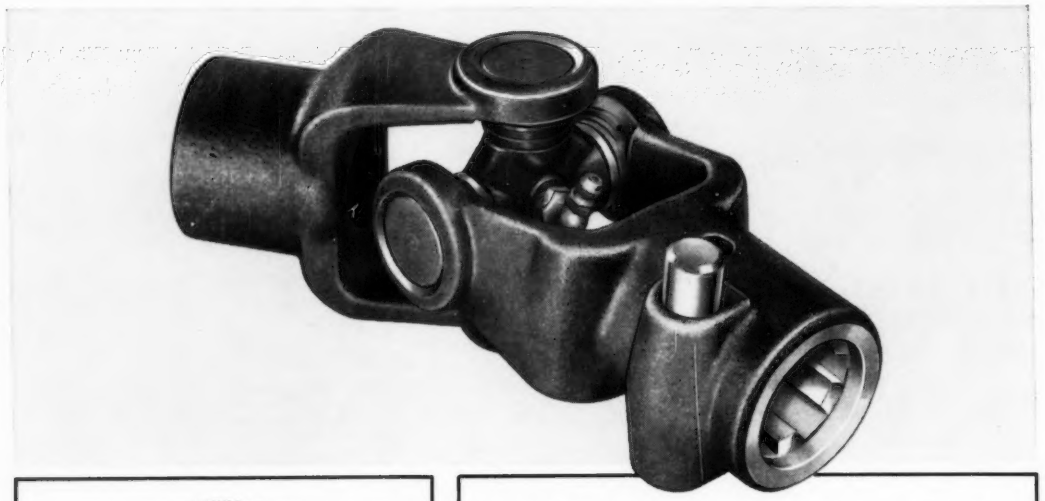


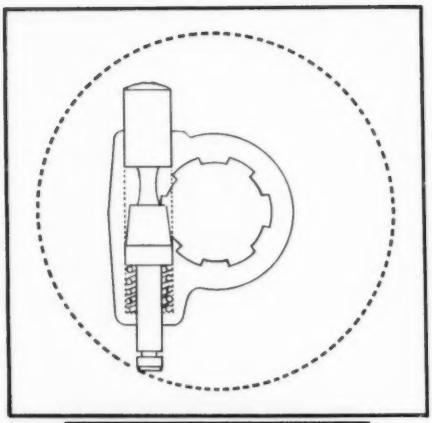
OTHER ESSENTIAL BORG-WARNER PARTS for tractors and plows are (1) Soft-center steel for moldboard plows and shares by Ingersoll Steel Division; (2) clutch by Rockford Clutch Division; (3) hydraulic pumps and valves by Wooster Division; (4) universal joint and (5) propeller shaft by Mechanics Universal Joint Division; (6) carburetor by Marvel-Schebler Products Division; (7) timing chain by Morse Chain Company; (8) radiator by Long Manufacturing Division; (9) seat, and other stampings, by Ingersoll Products Division. Also contributing to agriculture are the Borg & Beck, Marbon Chemical and Spring Divisions.

WHAT BORG-WARNER MEANS TO YOU!

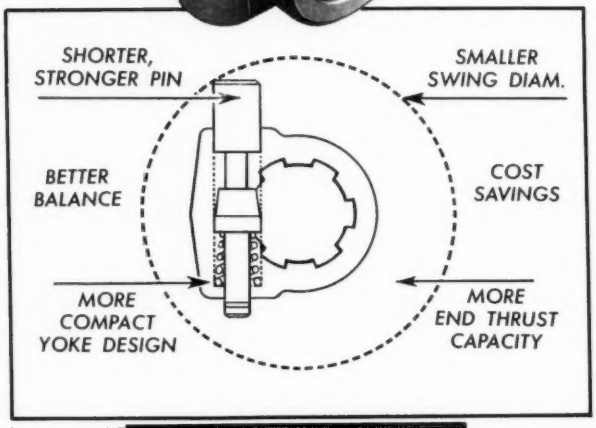
Tour the aisles of a food store, and you're flanked by America's bounty—country-fresh dairy products, a Maine-to-California variety of fruits and vegetables, a refrigerated case full of meats, fish and poultry. Here's taken-for-granted freedom from want, nutrition for your family, treats for taste buds. Extend an appreciative nod in the direction of the farmer, and he will share the credit with others—with, for instance, the parts and products made by divisions and subsidiaries of Borg-Warner Corporation.

IMPROVE YOUR PTO DRIVES WITH NEAPCO'S QUICK-DISCONNECT!





STANDARD "Q.D." DESIGN



IMPROVED NEAPCO DESIGN

Design smoother running and more safety into your products with Neapco's quick disconnect. Capacity tests have proved the shorter pin will take more end thrust load than standard designs. The smaller swing diameter is safer, more compact, better balanced, reduces weight, saves on cost. Available for light, medium and heavy duty applications.

The Neapco Quick Disconnect yoke is used as original equipment by many leading manufacturers of PTO driven farm implements.

Look for it on the machinery you buy.

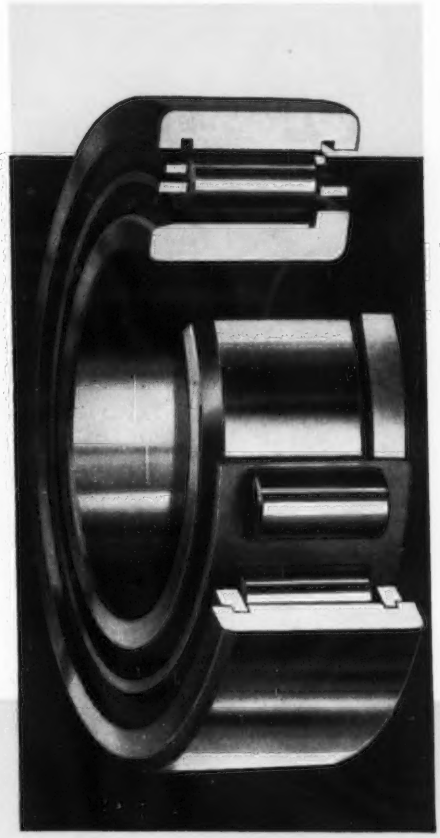
VALUABLE DESIGN ASSISTANCE

1. 16-page catalog with detailed data, specifications for light, medium, heavy duty. **2.** Yoke drawings for design tracing, plus data sheets. **3.** Special design service. They're yours for the asking. **Write Neapco Products, Inc., Pottstown, Pa.**

A COMPLETE SOURCE FOR UNIVERSAL JOINTS AND DRIVES, SINCE 1921

TRADE NEAPCO MARK ®

Aetna
ROLLER BEARINGS



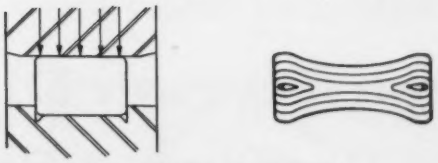
True Crowned for 15% longer service life

Because each Aetna roller is *True Crowned* with a large radius, high stress points in the rollers are relieved—giving 15% longer bearing life. The crown radius is scientifically determined and varies with the roller size.

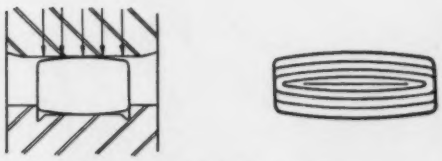
Aetna offers a wide range of self-contained *True Crowned* pure radial roller bearings in both custom and standard designs—also many special designs of both pure radial and pure thrust bearings for unusual applications.

For complete information on *True Crowned* Aetna Roller Bearings, call your Aetna representative listed in your classified telephone directory, or write for General Catalog and Engineering Manual.

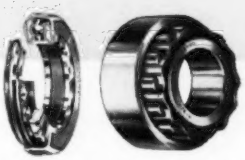
True Crowning as produced by Aetna.



Straight roller showing stress pattern at roller to race contact.



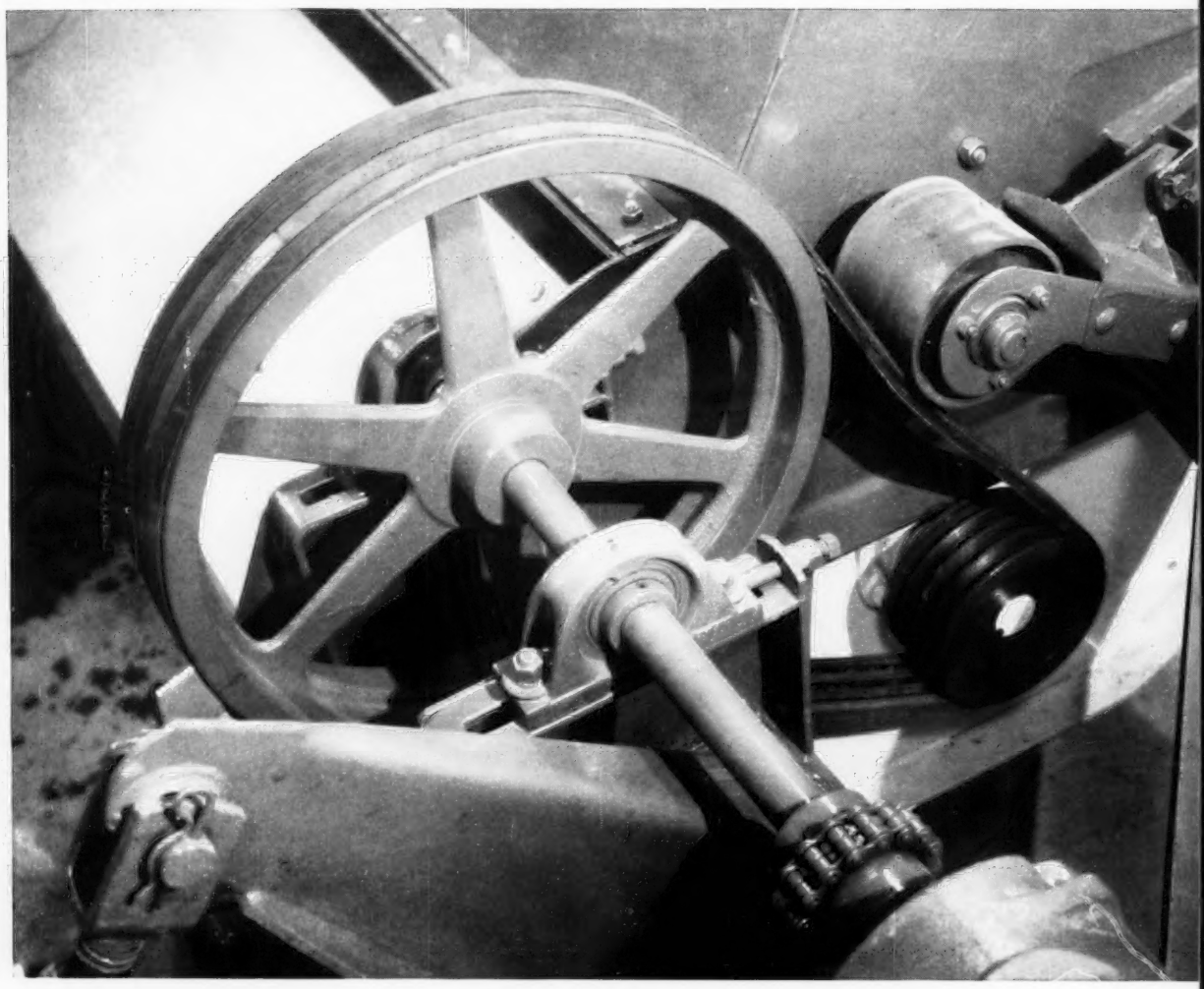
True Crowned roller showing stress pattern at roller to race contact.



AETNA BALL AND ROLLER BEARING COMPANY
DIVISION OF PARKERSBURG-AETNA CORPORATION

4600 SCHUBERT AVE.
CHICAGO 39, ILL.

ANTI-FRICTION SUPPLIERS TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916



"Four Dayton Die-Cut V-Belts Out Perform 6 Standard Belts"

"Belt slippage and failure constantly plagued us when we used conventional V-belts on the pilot model of our Super 60 Forage Chopper," says Mr. Vernon Lundell, Pres., Lundell Mfg. Co., Cherokee, Iowa. "We faced the possibility of having to redesign the drive from a 4 Belt to a 6 Belt unit to get the power we needed."

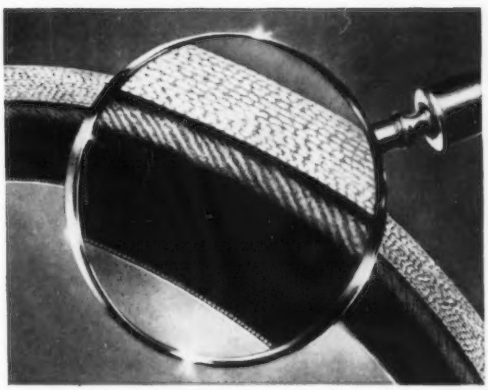
"Our engineers consulted the Dayton representative who recommended a *Dayton Die-Cut, Agricultural V-Belt.* It was the perfect answer. The Dayton Belt easily transmits up to 40% more horsepower than any other belt we have ever tested. Its high coefficient of friction (due to Dayton's exclusive Die-Cut construction) eliminated slippage completely . . . thus solving once and for all the friction and heat conditions which materially reduce the work-life of any V-Belt."

"Exhaustive testing by our engineers has proven that four Dayton Die-Cut V-Belts will actually out-perform a drive system using six conventional V-Belts. That is why we use Dayton V-Belts exclusively and highly recommend them for production line replacement and quick substitutes in the field."

The Lundell Super 60 Forage Chopper performs a wide variety of jobs including hay pick-up from windrow; cutting broadcast cane, alfalfa and brome; grinding corn, etc. This versatility is accomplished by means of quick change cylinders with various sizes of driven sheaves to control speed of operation. As a result the Belts have to handle many different loads and a wide range of speeds.

In the nine years since Lundell Mfg. Co. started using Dayton Die-Cut Agricultural V-Belts not a single one has ever broken. According to Mr. Lundell (shown here left), "We know of no other V-Belt that can even begin to match this outstanding performance."

The Dayton Die-Cut Agricultural V-Belt has no cover to wear out . . . is specially compounded to continually renew its gripping surface as it operates (whereas conventional fabric-covered belts on this type drive wear smooth and slip). Abrasive materials . . . chaff, mud, chips, stone and metal particles . . . which tear covers and ruin other belts . . . have no such effect on the Dayton Die-Cut Agricultural V-Belt, and can actually **add** to its gripping strength.



Dayton manufactures a complete line of V-Belts for all types of agricultural drives. For assistance with your standard or special V-Belt drives call your nearest Dayton representative or write to:

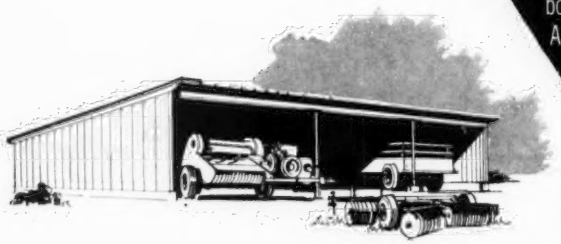
INDUSTRIAL DEPARTMENT

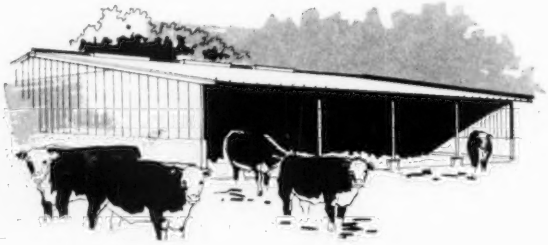
©D.R. 1960

Dayton Industrial Products Co.

2001 Janice Avenue Melrose Park, Illinois A Division of The Dayton Rubber Co.

New steels are born at Armco

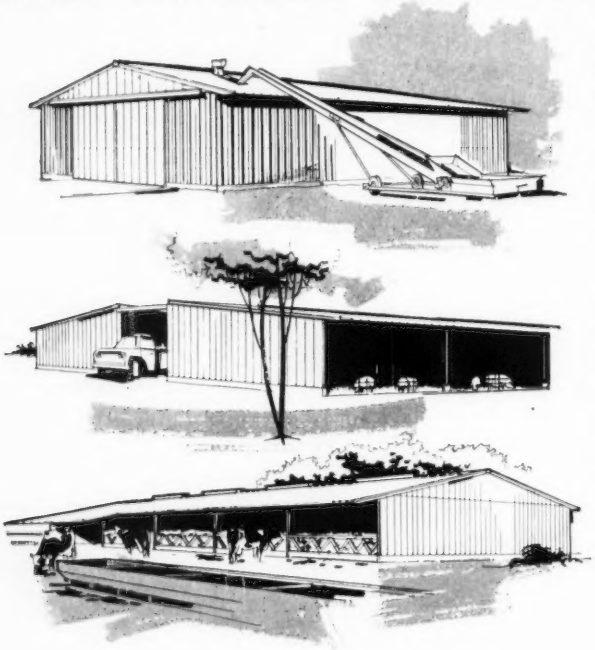




Rugged Construction...
Easy Erection...
Low Maintenance

MORE REASONS

WHY ARMCO STEEL BUILDINGS ARE A BETTER WAY TO BUILD



Heavy-gage wall panels in every Armco Farm Building mean more strength, more durability. These rugged panels fit together quickly and easily – buildings go up fast. Little or no maintenance is required.

An unlimited choice of sizes makes it easy to meet specific needs. Clear-span widths range from a few feet up to 120 feet. Get more information about the complete line of Armco Farm Buildings. Write for a copy of the Armco Farm Building Catalog. Armco Drainage & Metal Products, Inc., 5350 Curtis Street, Middletown, Ohio.

ARMCO DRAINAGE & METAL PRODUCTS

Subsidiary of ARMCO STEEL CORPORATION

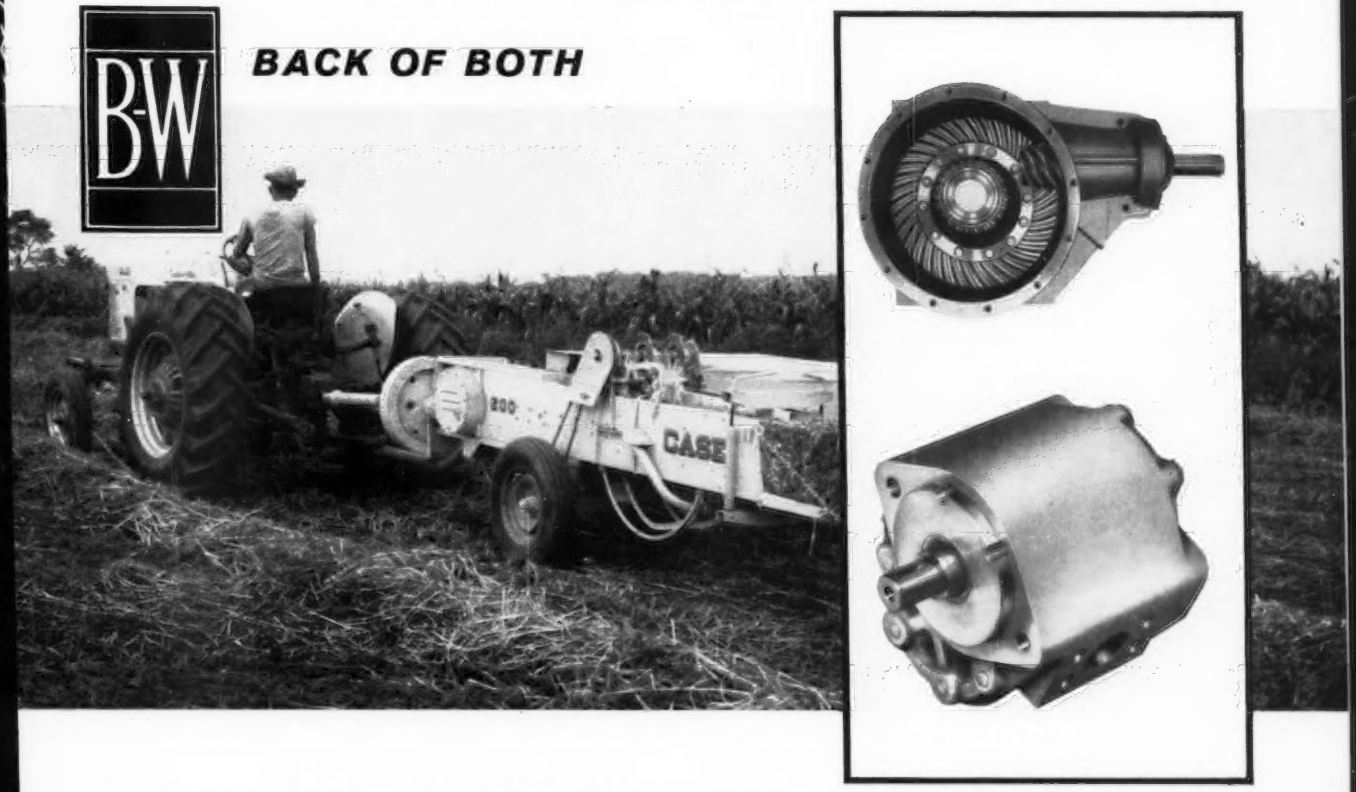
OTHER SUBSIDIARIES AND DIVISIONS: Armco Division • Sheffield Division • The National Supply Company • The Armco International Corporation • Union Wire Rope Corporation

TWO MAJOR SOURCES OF...

POWER TRANSMISSION

B-W

BACK OF BOTH



Another stronger, yet lighter **HAY BALER GEAR BOX BUILT BY WARNER AUTOMOTIVE**

Famous J. I. CASE engineers came to Warner Automotive, specialists in mechanical power transmission, for a rugged but lightweight gear box to complete a new simplified, surge-free power train for the CASE 200 SweepFeed Hay Baler. Warner engineers produced a gear box with a malleable iron housing, carburized hypoid gears, integral ring gear carrier and splined crankshaft, anti-friction bearings and tapered root spline on input shaft. It withstood the most exhaustive tests CASE engineers could devise. All CASE 200 SweepFeed Hay Balers are equipped with this superior, high capacity B-W Gear Box.

Another outstanding series of

B-W HYDRAULIC GEAR PUMPS...

P-3 SERIES

CAPACITIES 8.0 to 21.0 GPM at 2000 RPM and 2000 PSI
DISPLACEMENT 1.0 to 2.7 CU. IN.
(For maximum speeds, consult our engineers)

Standard S.A.E. mounting and drive shafts . . . optional porting: side, rear or combination . . . special alloy tin-aluminum bearings, used in heaviest-duty industrial engines . . . all bearings interchangeable . . . double lip shaft seal . . . hardened and ground steel gears and shafts . . . high quality, high tensile aluminum bodies for light weight.

For Complete Information Write NOW

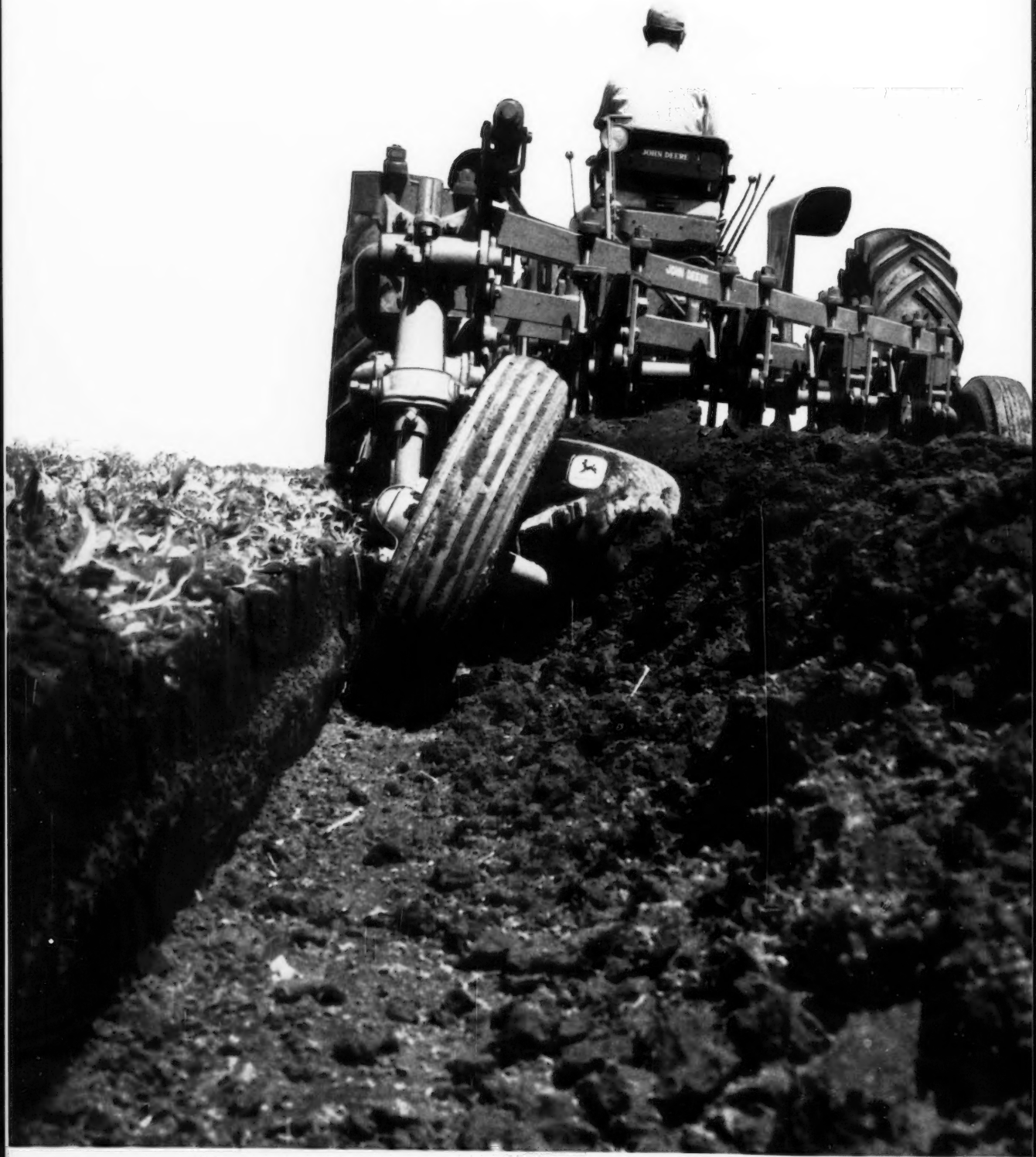
WARNER AUTOMOTIVE
DIVISION—**BORG-WARNER CORPORATION**
Auburn, Indiana

WOOSTER DIVISION
BORG-WARNER CORPORATION
Wooster, Ohio

Export Sales—**BORG-WARNER INTERNATIONAL**—36 S. Wabash Ave., Chicago 3, Ill.

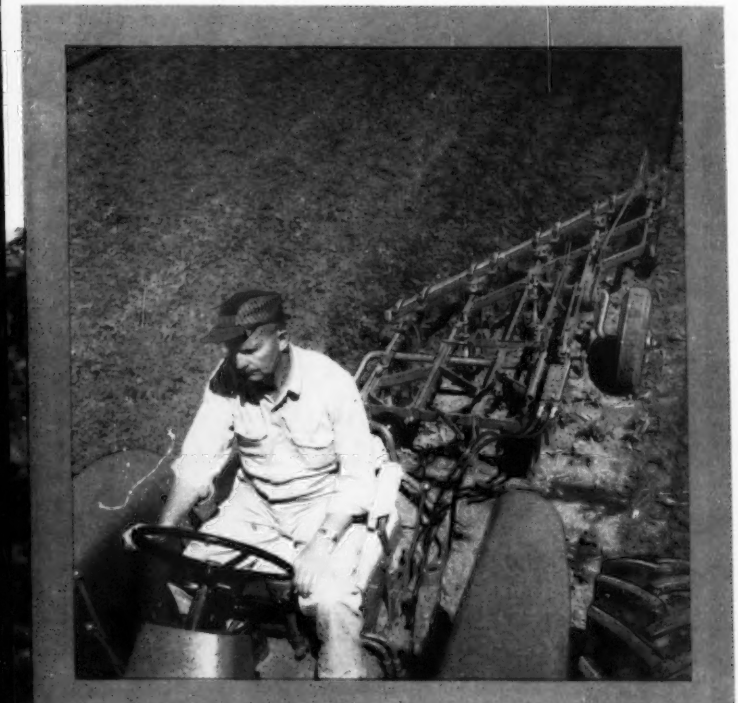
IT'S A BETTER PRODUCT WHEN BORG-WARNER HAS A PART IN IT

Any way you look at it, **You Can't**



Beat John Deere Plowing

When farmers discuss other plows, you'll hear— "How do they measure up to John Deere?"



Everything a farmer wants from a plow—good tillage, fast work, convenience, low operating cost (or all four)—*he'll find in a modern John Deere.*

Crop-boosting tillage

John Deere high-speed, light-draft bottoms are widely and justly known for thorough soil conditioning. They take depth fast and hold it. They fracture—not pulverize—the furrow slice. They scour well even in adverse soils.

John Deere Plows have plenty of clearance for deep, clean work in heavy trash. They're easy to adjust for best possible plowing in any soil . . . easy to handle—and easy on tractor fuel.

Many farmers say they're plowing one gear faster (to the same depth and with the same tractor) or using a bigger plow since they switched to John Deere. That's not hard to understand—John Deere bottoms have unusually light draft, and John Deere line-of-draft hitching makes efficient use of power.

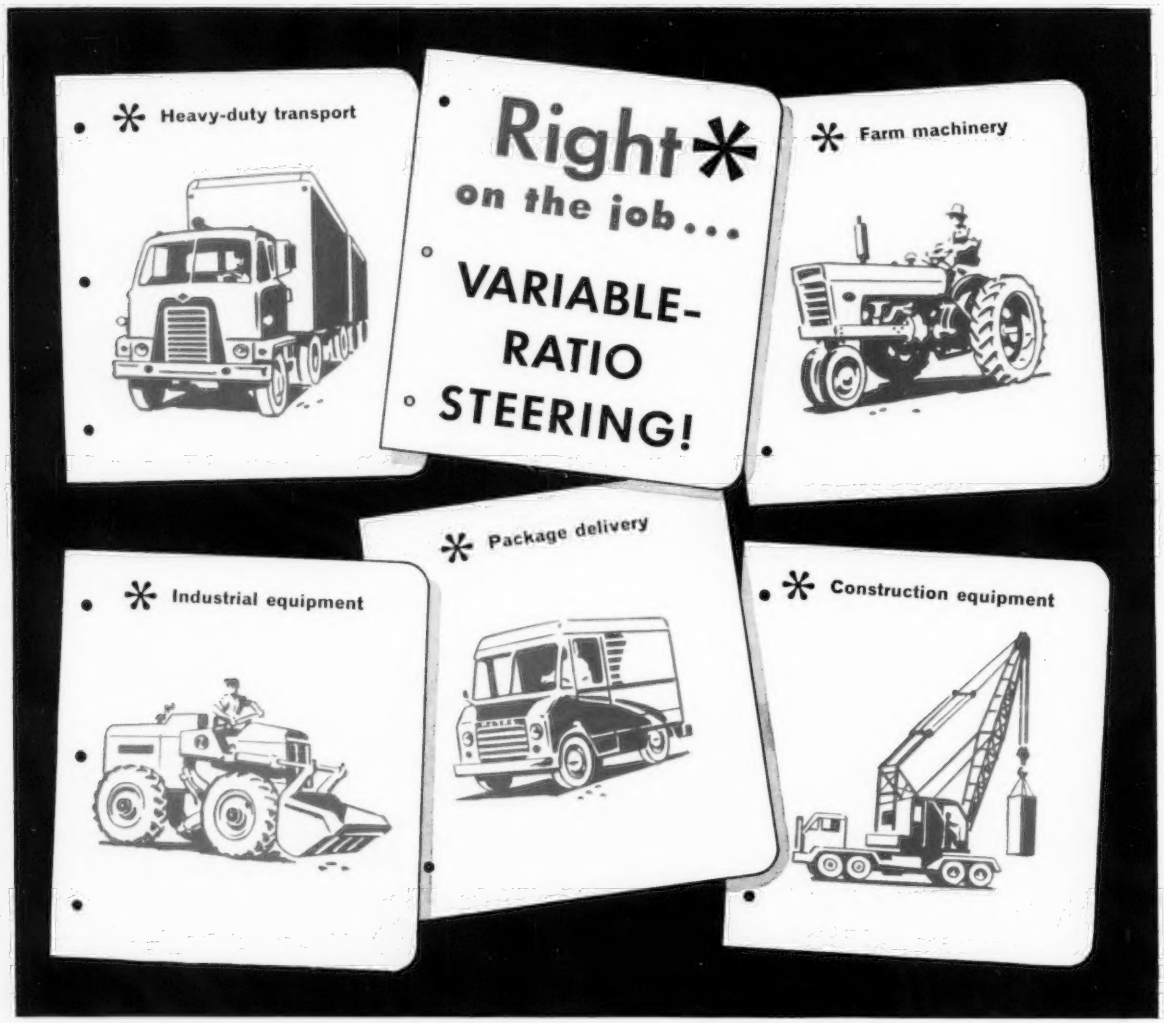
Low-cost shares

Farmers are pleased by the low cost of durable, surface-conditioned John Deere shares. They also have learned from experience that the rugged, Truss-Frame strength of John Deere Plows means long life, complete dependability, and rock-bottom maintenance costs.

Now you know some of the reasons why thousands upon thousands of value-wise farmers prefer John Deere Plows. *Any way you look at it*—good tillage, fast work, convenience, operating economy—*you can't beat John Deere plowing.*

JOHN DEERE
MOLINE, ILLINOIS

"Wherever Crops Grow, There's a Growing Demand for John Deere Farm Equipment"



Constant Ratio

Variable† Ratio

†Originated and developed by Ross

Ross STEERING

● Wherever the job calls for alert, responsive, fatigueless steering . . . Ross *variable-ratio* steering is at its best!

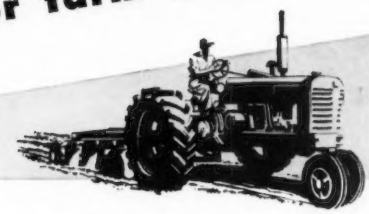
Ross *variable-ratio*—faster steering and quicker recovery for turns, and slower steering and greater stability for straight-ahead handling—has been adopted by 31 of today's leading vehicle manufacturers. Ross invites *your* inquiry.

ROSS GEAR AND TOOL COMPANY, INC. • LAFAYETTE, INDIANA

Gemmer Division • Detroit

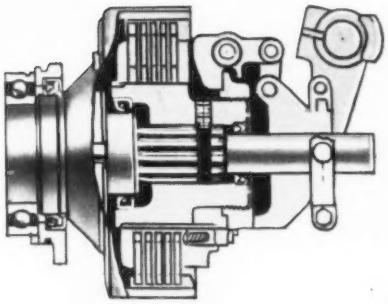
TWIN DISC

heavy-duty friction and fluid drives for farm machinery



A critical component in any machine is the part that transmits engine power to driven equipment. That's why leading farm machinery manufacturers specify Twin Disc heavy-duty, industrial-type friction and fluid drives.

Since 1918, Twin-Disc has specialized exclusively in products for applying horsepower—efficiently and dependably. Today Twin Disc is the world's leading manufacturer of friction clutches, fluid couplings and torque converters for industrial applications. Twin Disc produces a *complete* line of drive components and therefore can offer machinery manufacturers and users *unbiased recommendations* as to the most advantageous—and profitable—drive for any farm machinery.

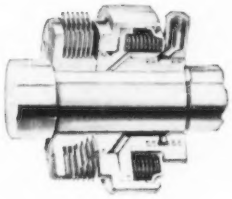


Farm Tractor Clutches

Twin Disc multiple-plate clutches are used in the drive trains of such leading tractors as the Minneapolis-Moline 445 and the Oliver Super 55. They are built for the rugged service expected of farm machinery. Choice of wet or dry types. Standard designs can be modified to meet special requirements. Write our Racine office for full details.

"Stripped" Single Stage Torque Converters

Housingless units for incorporation in any tractor drive line of appropriate capacity. Compact and ruggedly built, they permit manufacturers to offer the sales appeal of torque converter drive at lowest cost. **1100 Series** — for engines to 188 hp and 265 lb.-ft. of torque. **1300 Series** — for engines to 212 hp and 330 lb.-ft. of torque. Five torque ratings permit close matching of converter to engine for maximum efficiency and fuel economy. Optional equipment: Lock-up direct drive or oil-actuated master clutch.



Oil-Actuated Multiple-Plate Clutches

Designed for a wide variety of applications, these clutches are built to run in oil and are actuated by oil pressure of 100 to 300 psi. No adjustments are needed because ram travel compensates automatically for wear. Seven sizes 3" to 7" in diameter. Horsepower capacities from 9 to 137; torque capacities from 37 to 690 lb.-ft. Model DOC (illustrated) has an around-the-shaft oil collector connected by a ¼" line. On Model DO the oil collector is omitted, shortening the clutch somewhat.

Twin Disc's very first product (introduced in 1918) was a friction clutch for farm implements . . . and Twin Disc has been supplying the farm machinery industry with friction and fluid drives ever since. You get the benefit of 41 years' experience when you specify Twin Disc drives.

Twin Disc Clutch Company, Racine, Wisconsin. Hydraulic Division, Rockford Illinois.

TWIN DISC

Friction Clutches and Fluid Drives

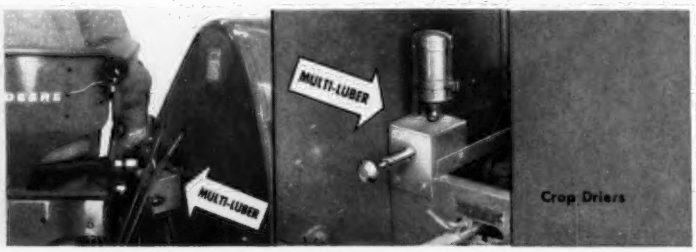
Breakdowns at the peak seasons of planting and harvest aggravate a farmer, may sour him on a particular brand of equipment. That's why Lincoln's Multi-Luber Centralized Lubrication Systems are being incorporated as original equipment on more and more farm implements.

A low-cost Multi-Luber System will end downtime for lubricating, and keep all bearings rolling on a film of refinery-fresh lubricant. The system is sealed so that no dust, dirt or abrasive gets to the bearings.

Under pressure, a measured amount of lubricant is injected into all bearings, in seconds, while the machine is operating. Multi-Lubers can be actuated by air, by vacuum or by hand. Models are available for every type machine and job.

Add sales appeal, long service life and greater customer satisfaction to *your* product by designing with the Lincoln Multi-Luber. Write the Original Equipment Division today for Catalog 50 and complete specifications.

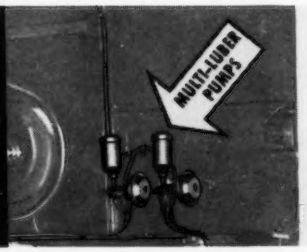
modern farm machinery depends on Lincoln *Multi-Luber*® systems for dependable lubrication



Mounted or Pull-Type Corn Pickers

Crop Driers

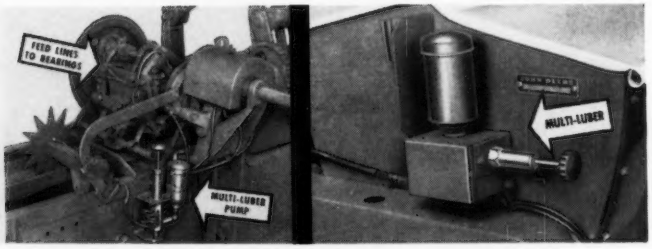
Huskers and Shellers



Combines (Push-button, power-operated systems for self-propelled machines)

Hay Balers (left)

Grain Drills and Fertilizer Distributors (right)



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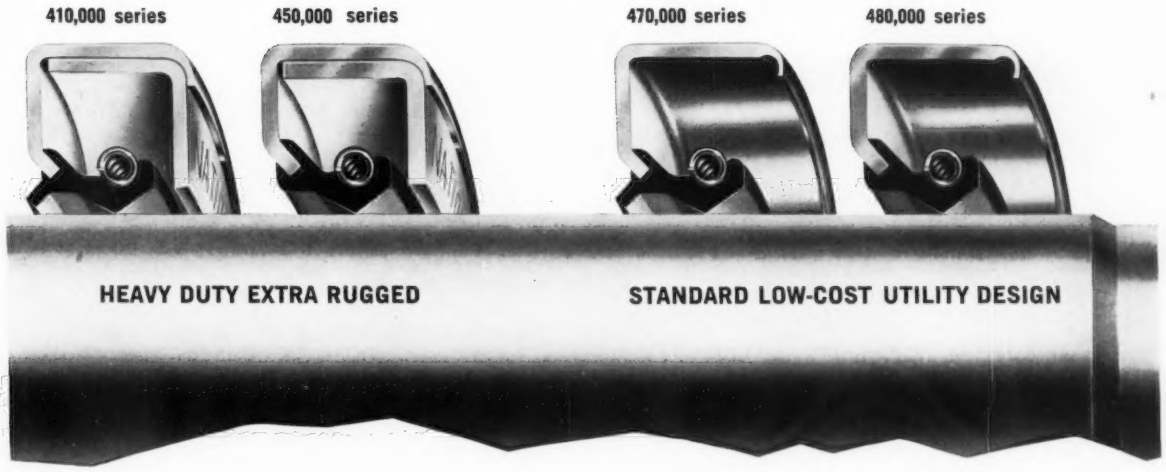

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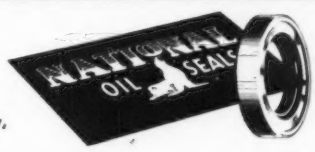

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James Basselman, *Editor*

CHANGES IN EDUCATION IN RELATION TO AGRICULTURAL ENGINEERING

IT is amazing how great the changes have been in education in this century, and yet how unsuccessful education has been in keeping up with the changes in the physical, social, and moral worlds in which we live. Doubtless this is due to the fact that education has traditionally been somewhat divorced from the changes occurring in the market place and the international forum. We have taught history, language, and mathematics with greater success than international relations or economic trends, because of the relative stability of the classical areas. In fact, it has been impossible apparently to keep college courses, on the average, closer to current conditions than a generation or about twenty years.

In a slower moving civilization, which might be represented by any period before 1900, education that took into consideration the innovations faced by all except the immediately preceding generation would have served quite admirably. Only the three generations of this century have faced such an acceleration of change that normal educational processes have fallen farther and farther behind our needs. Higher education shows little evidence as yet of being able from within its ranks to accelerate the procedures of change demanded of every level of education by the continually changing responsibilities that face our form of civilization. It seems to me that we who cherish educational freedom should realize that education must progress with the speed of the world it serves or change will be imposed upon it as an act of survival by an endangered and perhaps angered society.

Public School Education

As an example of a great educational innovation that was based in part upon natural influences, but has failed to keep pace with world changes, we can consider the public schools. In the special issue of October 10, 1959, of *School and Society*, there are a number of articles in eulogy of John Dewey, philosopher and educational prophet. That John Dewey had a great influence upon public education is made clear by a few comments of those who greatly admire his philosophical concepts. Junius L. Meriam of the University of California quotes Dewey's words: "Learning? Certainly, but living primarily, and learning through and in relation to living." In this short quotation we have the essence of the change from school discipline to school-room living that has so fixed the character of progressive education.

L. E. Grinter, Dean of the Graduate School, University of Florida

Another of Meriam's quotations from Dewey points in the same direction, "I believe that the only true education comes through the stimulation of the child's powers by the demands of the social situation in which he finds himself." In following this advice teachers are constrained to establish the right social situation in the classroom, which has led to play as an inherent part of the educational program in place of a recess for relaxation. Maxine Greene of New York University mentions Dewey's satisfaction with educational reform when he observed that teachers were experimenting in bringing about the adjustment between children and their environment by means of "learning by doing" procedures.

In much of his philosophy, Dewey pressed for experimentation as an application of the scientific method to education. Isaac B. Berkson of City College of New York says: "I have come to have serious doubts about the tenability of experimentalism as Dewey finally expounded it, i.e, as an all-embracing unitary method equally valid in all areas of knowing – moral as well as scientific, esthetic as well as intellectual." It seems that Dewey was overly impressed by the success of science in his early years, before 1900, and believed that the crude scientific experimentation of that day pointed the way toward success of broadside experimentation in the fields of social, economic and moral values even when essentially devoid of conceptual guidance. One could hardly have failed to be impressed with the achievements of Edison and many others whose empirical experimentation, almost unguided by modern theoretical concepts and mathematical analysis, produced marvel after marvel.

We now know that these early experimenters were merely lifting the lid on the Pandoran box of modern science. Within two or three decades shotgun experimentation passed the stage of diminishing returns in the well-worked fields of science, engineering and agriculture. The fact is that the relatively crude experimentation dictated by the inherent nature of social situations, which involve large numbers of variables, can never be expected to provide answers to most social and moral problems. Isaac Berkson correctly states that "All important advances in scientific theory in modern times through Gallileo, Newton and Einstein have been accompanied or preceded by the acceptance of a mathematical approach or by advances in mathemetical science." So Dewey, by undervaluing theory in producing scientific advances and by overacceptance of the crude experimental approach of his day, set off a trend in our schools that is still neglecting symbolism whether in language or in numbers.

Furthermore, Berkson notes that the "criticisms (of Dewey's experimentalism) imply a retention of the more traditional forms of instruction, e.g., the division of the course of study into subjects or broad areas, emphasis upon knowledge, content and on general principles, and regard for precision, clarity and consistency." I might add that it should indicate to colleges of education that their future usefulness lies in closer association with departments of psychology and sociology whose fundamental researches must furnish the scientific background of education, rather than in continued dependence upon questionnaires and round-table discussion by students which are supposed to bring forth knowledge, wisdom and truth. In the area of moral principles, according to Berkson, "we can at most have testimony—the testimony of prophets and saints, of philosophers and statesmen, the testimony of long experience voiced in literature, the testimony of the values and ideals to which as members of the human community we respond." This testimony seems unlikely to develop spontaneously at a round-table conference of students whether they be sophomores, seniors, or graduates. It must

(Continued on page 177)

An address before the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1959.

The author — L. E. GRINTER — is dean of the graduate school, University of Florida, Gainesville.

Accelerated Testing of Farm Machinery

Arnold B. Skromme
Member ASAE

Provision for a thorough engineering approach to all phases of a development and design problem

ACCELERATED testing of farm machinery has become a necessity for three reasons:

(a) To improve quality of the product
(b) To reduce testing time and costs
(c) To maintain a high level of annual sales.

Accelerated durability tests usually result in higher quality products than do test programs where all durability testing is done on farms along with functional testing. Even if it were feasible to wait ten years for a machine to wear out, this would not provide sufficient time since it would be necessary to repeat tests if weaknesses showed up at, say, the one-half and three-quarters development stages.

When tests are automated and accelerated, costs for both test mechanic and design engineer are reduced. The quality of accelerated testing is constantly being improved by establishing reliable correlations between artificial durability tests and actual field results. The correlations shown in Table 1 are preliminary and are still in process of being verified. However, they represent some of the information needed to carry out good durability test programs.

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1959 on a program arranged by the Power and Machinery Division.

The author — ARNOLD B. SKROMME — is chief product engineer, John Deere Spreader Works, Deere & Company, East Moline, Ill.

Acknowledgment: The author acknowledges the assistance of A. W. Oehler, chief product engineer, John Deere Harvester Works for information pertaining to the testing of combines, and to C. T. Rasmussen, project engineer, John Deere Industrial Equipment Works, for information concerning disk harrows.

Shortened test programs make it possible to respond more promptly to customer requests for changes in machine types and requirements. This means that the machines will enjoy a longer productive life before becoming obsolete, which makes it easier to amortize tooling costs.

Surveys and Machine Specifications

One test engineer stated: "The easiest way to shorten both functional and durability testing is to design the machine properly in the first place." It is important that a complete and thorough set of specifications be prepared before the first machine layouts are begun. The test engineer, together with the design engineer, sales department representatives, and other advisors should thoroughly review and discuss the specifications before design work is begun.

Surveys must sometimes be made before specifications can be completed. Product research or sales departments should collaborate with design engineers to form survey teams. When specifications are being written on a machine that is completely new to the design department, the design engineer should personally interview at least ten farmers or contractors who make their living using this type of machine. The owner-operator is always asked for a list of all repairs, adjustments and changes that have been made in a machine, the features he likes and dislikes, and the model or brand of machine he would buy tomorrow if he were purchasing another machine. A list of the special features he would like to see in the machine, and not found in any present-day machine, is also included.

TABLE 1. CORRELATIONS OF ACCELERATED TESTS WITH FIELD RESULTS (Preliminary Only)

No.	Machine or Mechanism	Test Procedure			Equivalent to
		Speed	Duration	Obstacle or condition	
1	Heavy-duty elevator	6 mph	1200 bumps*	30 deg by 5½ in. by 60-deg drop; 100 lb added to head and 40 psi tire pressure	Normal shock life of wheels and frame
2	Regular-duty elevator	6 mph	1200 bumps	Same but no weight in head and 26 psi tire pressure	Normal shock life of wheels and frame
3	Forage wagons and manure spreaders	6 mph	12,000 bumps	30 deg by 5½ in. by 60-deg drop — maximum pay load	Normal shock life of wheels and frame
4	Flails for spreading manure	750 rpm	300 hrs	Operate with tips of blades submerged 3 in. in water	Normal fatigue life, excluding severe shock loads
5	Ratchet-driven conveyor in 134-bu spreader	Normal	40 hr for chain and 200 hr for balance	Prony brake set at 7300 in.-lb with two teeth engaged	Normal life of drive
6	V-belt on variable-speed combine transport drive	Normal	1500 cycles	Zero load to peak shock load	Desired life for shock loads only
7	Folding hoppers for elevators and blowers	——	500 slams each way	Slammed hard against ground and against stop in "up" position	Normal life
8	Bearing seals	465 rpm	One-half of desired life	Volcanic ash dust cloud — not submerged — 110 F	Desired life
9	Self-propelled combine	——	——	Drop combine 6 in. to concrete floor by cutting support bolt	Maximum field bump (for strain gage work)
10	Hydraulic loader	12 gpm	20,000 cycles	Raise 1500 lb to 8 ft and drop 5 ft. Catch hydraulically. Load is one-third off center	Normal life excluding headon shock loads
11	Hydraulic loader	4 mph (out of gear)	10 times	Ram bucket against 4 x 4 wood backed by concrete	Maximum shock load
12	Bolster hoist	Normal	16,000	Raise 5 tons, drop in 4 sec and catch hydraulically	Normal life
13	Disk harrow	20 shocks per min	5 hr	Apply heavy shock load to several points on frame	250 hr of normal field usage

*One to four rebounces per bump

In some cases, when complete agreement cannot be reached on all parts of the specifications, two or more test machines are made up in the first run, each with different features. This also accelerates testing, as concurrent tests may be made instead of consecutive tests.

Models and Early Component Testing

Some problems can be studied fairly accurately with models. Fig. 1 shows a model of an elevator being studied for stability and boot weight in different operating positions. Fig. 2 shows a paper model of a difficult joint assembly, which was studied by production and factory methods people, as well as by the engineer who had to make the layout drawings. Models can also be used to study operator visibility, clearances and articulation problems before layouts are completed.

Much time can sometimes be saved by first designing a particular component of a machine that is entirely new, and testing it before the rest of the machine is completed. Fig. 3 shows a drive axle and final drive of a new combine undergoing a thorough load test before the other parts of the machine were finished. Fig. 4 shows a combine component undergoing comprehensive load and durability tests before drawings were completed on the rest of the machine. Other examples include new gearboxes, new harvesting components, and new axles.

Severe Test Conditions

Some progress has been made in shortening tests of farm machines by the following methods:

Increase Speeds. This must be done with care, since increased speeds can sometimes cause early premature failures, or artificially improve the function or the strength of the part. Increases up to 25 percent are often used.

Increase Loads. In this case care must be taken and the critical point of the test must be determined before such loads are applied. Usually, however, it is safe to operate the machine continuously at 100 percent of the farmer's maximum loads.

"Careless Farmer" Servicing. A minimum amount of greasing can be applied to the machine, assuming that a certain percentage of farmers will be negligent in this respect. Belts, chains and slip clutches should be operated both too tightly and too loosely. Maximum temperature variations can be used.

Concrete Test Tracks. This is the most popular method used to obtain transport tests that can be repeated accurately. Measurements of wear points, straightness checks and wheel and axle settings should be recorded as the experimental model is assembled. The use of dirt, gravel or black top roads is not accurate for torture track work, as rains and road maintenance crews can easily alter the severity of the bumps. With manmade obstacles, experimental models can be compared accurately with production machines (Fig. 5).

Increase in Testing Efficiency

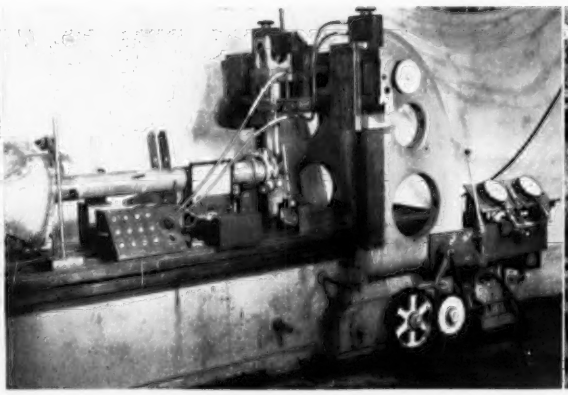
Increase Testing Hours per Day and Days per Year. Laboratory tests can often be operated 24 hours daily with the use of microswitches set near parts expected to break, and with the use of hourmeters, cyclecounters and time-lapse switches. In field testing the use of lights and two shifts are sometimes used.

Following the season from the Mexican to the Canadian border can often double the number of test days per year. The use of cabs with both heat and air-conditioning increases the useful hours per day. Indoor soilbeds can eliminate weather hazards in tillage work.

Elimination of Loading and Hauling Time. A manure spreader hauls about 16 loads per day, requiring only two minutes to spread each load, resulting in 32 min of power train test time per day in actual field testing. However, when the spreader is subjected to continuous testing on a drone test setup (Fig. 6), twenty years of test time can be obtained in four months. Power is received from a tractor power take-off, with a tractor set at a 20-deg angle to the tongue. The power passes through shafts, chains, gears, sprockets and ratchets, where the power required to operate the apron chain is absorbed in prony brakes. Power normally required to drive the upper beaters passes through a hammermill to obtain a speed increase, and then into a dissipating air fan. In this case, it was possible to obtain tests on a hammermill drive at the same time tests were obtained on a spreader.

Concurrent Testing. If two models of a machine are made from the first experimental drawings, functional testing can be done with one machine, while durability testing is done with the other. For example, an elevator could be operated over a test track at the same time a similar elevator is undergoing functional tests in many types of grain and forage material. Results of tests on both machines can then be combined into a second experimental test model. Concurrent testing also means that two machines may be tested functionally in different crops in different parts of the

Fig. 1 *(Left)* **Elevator model under study to improve weight-transfer and safety devices. • Fig. 2** *(Right)* **Paper model of joint with difficult transition and rotation problems**



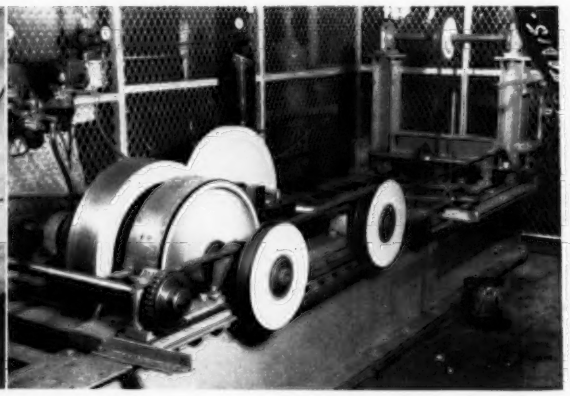


Fig. 3 *(Left)* Indoor component testing on new combine axle. Force to be exerted by hydraulic cylinder on wheel hub was determined by field tests. Various types of gussets, mounting brackets, axle tubes and other features can be studied, to reduce stresses. • Fig. 4 *(Right)* This component test is used to determine required size of belt, bearings and shaft before the drawings are completed on the balance of the machine. Flywheel energy, center distances and pulley sizes can be varied

. . . Accelerated Testing

country. For example, while several models of a picker-sheller were operated in the tight-shuck corn conditions in the South and Southeast, other machines were operated in heavy-yielding corn areas in Iowa, while a third group of machines operated in corn with small ears found in the drought areas of the western plains. In component testing, as high as six different components from one machine have been tested concurrently in the laboratory.

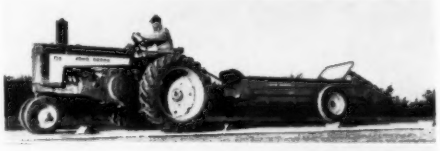
Testing by Suppliers. In some cases, suppliers can be encouraged and assisted in running tests on their components in their own laboratories. In one example (Fig. 7), a major rubber belt manufacturer purchased a John Deere tractor and hammermill for accelerated testing of belts in their own laboratory. Bearings manufacturers should be encouraged to conduct better tests in their laboratories, especially tests involving the wrapping of forage against bearing seals. Excellent cooperation was received from a manufacturer of agricultural roller chain in determining the best design dimensions for cast sprockets.

Stress Coat and Strain Gages. Testing can be accelerated by obtaining strain gage readings on current or competitive machines before layouts are begun on new machines, since results of these tests can guide the designer. As soon as the first model of a new machine is completed, it is usually stress-coated and operated on the test track, where preliminary tests have already been made to outline a test procedure. If test-track correlations are not available, the machine is used in actual field conditions. Strain gages are applied to the areas indicated by cracks in the stress coating. Usually all of this work precedes durability test track work and field operation.

Automatic Operation. Automatic operation can be achieved fairly easily in the laboratory, but it is more difficult in test track work and in actual field conditions. Fig. 8 shows an automatic hydraulic testing machine used to operate loaders or bolster hoists. Fifteen hundred pounds is lifted by the booms and tilted in the bucket. The load is placed one-third off-center. Fig. 9 shows another complete-machine test, which has a ratio of "farm test hours" to "lab test hours" of about 50 to 1, assuming perfect weather and no weekends. The elapsed time ratio would approach 100 to 1.

Satisfactory Performance Levels

This is one of the most difficult problems in accelerated testing, particularly in torture-test work and laboratory testing. One of the most successful methods is to test to destruction a commercially satisfactory machine that has been on the market for a number of years. When determining the minimum number of test track laps for heavy-duty elevators, two standard company elevators were first operated to failure. Several competitive elevators were also purchased and operated on the test track before the new experimental model was run. In this way, the preliminary tests involving type of loading, forward speed, bump height and other features were determined on machines that could



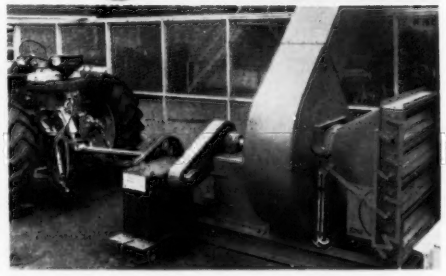


Fig. 5 *(Top)* Test truck on which a reduction in test time from 10 "farm years" to 5 days can be made. • Fig. 6 *(Center)* An automatic drone arrangement by which an entire power train can be tested. Prony brakes on each end of the front apron shaft effectively absorb the intermittent rotation exerted by the ratchet-wheel drive. • Fig. 7 *(Bottom)* Correlations between farm and laboratory belt tests are obtained with complete tractor and hammermill combination

be bought at production prices. This prevented the destruction of expensive test models before the final tests were started. In some cases, four or five machines have been destroyed before proper test procedures were established.

Excellent correlation has been achieved between repetitive tests made on the concrete test track. In one case, a competitive elevator failed at 264 bumps during the first test, and 276 bumps in a second test. Correlation must also be established between field failures and test-track failures. Sometimes this requires several years to obtain, but once it is obtained subsequent tests can be made on a test track at a fraction of the time and cost required to locate failures in normal farm work. The durability-test knowledge increases with each succeeding test, and this reduces both testing time and costs.

The use of popular current models in functional testing is also necessary to make certain new models will exceed them in every way.

An ASAE committee could perform a worthwhile service by helping to expand the number of known correlations to increase the size of Table 1. These correlations may be used to help establish ASAE standard capacity ratings, such as those contemplated for wagon running gears. It must not be assumed, however, that these correlations will ever completely replace farm durability tests.

Pilot Runs

Final test time can often be reduced by producing a pilot run of about 1 percent of full annual production, usually ten to fifty machines. Our experience has shown that it is advisable to produce a small run of about fifteen units, and follow each one closely with factory test mechanics and engineers. Producing them in the factory shop makes it possible to educate the production people and to check out temporary patterns, jigs and dies, and gives more accurate test results because the machines represent production quality. The machines produced in small lots are usually not sold, as they must be moved to many different farms to obtain maximum test hours and numerous farmer opinions. Farmers or farmhands usually operate the machines. Large pilot lot runs are usually sold, but followed as closely as possible. Field reports must be promptly relayed back to the design engineer, as final tooling is often in process.

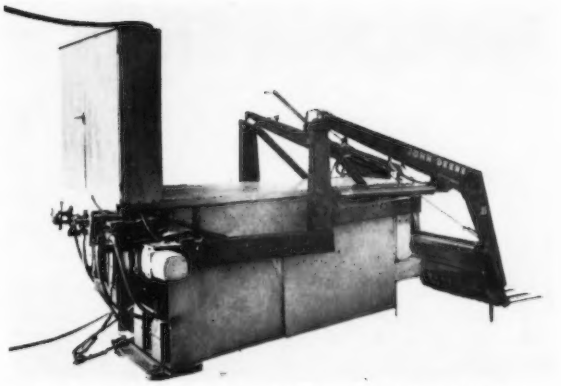


Fig. 8 Automatic testing in all kinds of weather can simulate loading 400 loads of manure in one day

Conclusion

Design engineers are well-equipped with technical knowledge covering new materials, advances in chemistry, mathematical equations, suppliers' old and new products, and similar information. Although this knowledge is being added to each day by engineers and other scientists, it is often difficult to properly design these advances into new machines because of slow, tedious and outdated methods of testing. We cannot always expect to obtain ratios of "farm test hours" to "accelerated test hours" of 50 to 1 as shown in Fig. 6. Considerable elapsed time was saved in correlation No. 4, Table 1, however, even though the drive was actually tested for 50 percent more cycles than it would receive on the average farm, for a "farm test cycle" to "accelerated test cycle" of ½ to 1. Accelerated testing does not mean to simply "hurry up" previous on-the-farm testing practices; it means a thorough engineering approach to all phases of the problem.

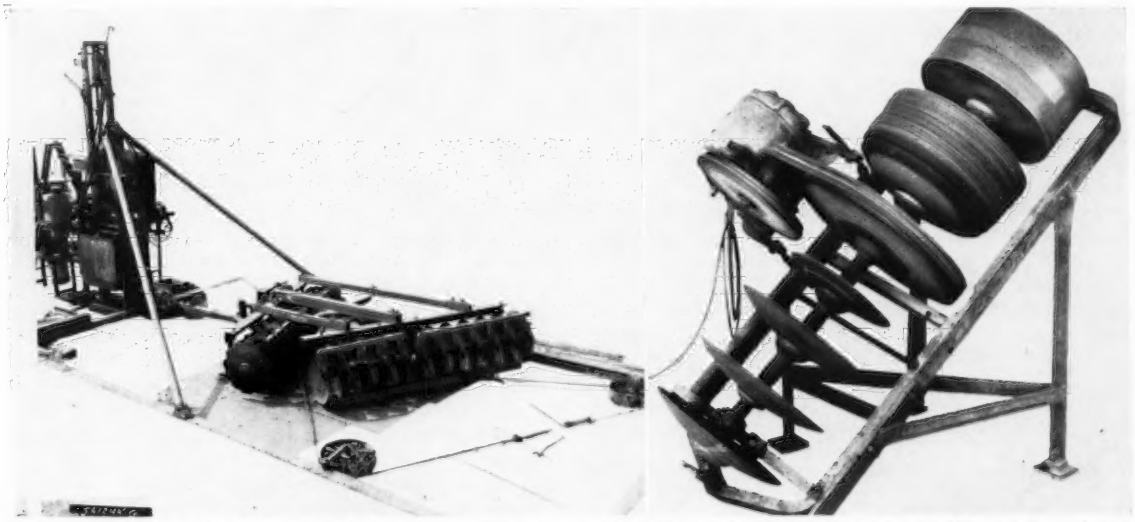


Fig. 9 *(Left)* Example of a complete-machine laboratory test setup developed by C. T. Rasmussen. Falling weights at left simulate a drawbar force on the tongue, which is transmitted through the machine into other cables which exert typical forces throughout the entire machine. • *(Right)* Rotating parts are concurrently tested with bearings operating in dust box at upper right end of shaft

Evaluating Effect of Land Use on Stream Flow

D. L. Brakensiek and
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Method for evaluating long-term trends in seasonal stream flow from small experimental watersheds

THERE is need to explore methods of adequately evaluating the comparative influence of land-use patterns on the long-term trend in the hydrology of small agricultural watersheds. The purpose of this paper is to describe and illustrate a procedure developed for evaluating long-term trends in seasonal stream flow from small experimental watersheds at Coshocton, Ohio. Also results of the analyses of seasonal stream flow are presented and discussed for several levels of land management. These land-management levels were imposed some twenty years ago on small experimental watersheds at the soil and water conservation station near Coshocton, Ohio, operated by the soil and water conservation research division, Agricultural Research Service, U.S. Department of Agriculture, in cooperation with the Ohio Agricultural Experiment Station. The term "stream flow" refers to discharge in the stream course at the gaging site, and thus is only part of total water yield.

Development of Concepts

Ultimately all stream flow is traceable back to precipitation. Precipitation that does not infiltrate becomes runoff immediately. That portion which does infiltrate may percolate through the soil and geologic material to eventually become stream flow, or it may be stored in the soil mantle for subsequent depletion by plants (transpiration) and direct evaporation. Data and studies at Coshocton will aid in considering *(a)* the influence of several management levels on the amount of infiltrated water and *(b)* the influence of several management levels on depletion of soil moisture.

Information on the effect of land management on infiltration for the Coshocton experimental area is available from an analysis of small single cover watersheds (4)*. Since runoff from these areas is mostly surface runoff, changes in amounts would infer changes in infiltration potentials. The findings indicated that those watersheds managed as described under treatment B† allowed more infiltration than those managed under treatment A†, except for Keene soils. (For the Keene soils, which have a tight layer close to the surface, percolation probably limits infiltration, so that an increase in infiltration could not manifest itself.) Data from small wooded watersheds indicate very little measurable stream flow. Thus the implication is that a woodlot cover affords an enormous infiltration potential.

Information on the depletion of soil moisture by the two levels of management is available from lysimeter data (1). In addition, information on ground-water level changes during the development of a wooded cover is available from a continuously gaged observation well.

Lysimeters Y103A and B have been managed according to treatment B. Lysimeters Y103C and D have been managed according to treatment A. A contrast was made of the percolation amounts for the two management levels. Percolation amounts indicate what portion of infiltrated water is available for deep seepage and potential contributions to stream flow. Indirectly they also indicate water used in evapotranspiration. After 19 years, percolation in the dormant season, November 1 to April 30, was 1.6 in. less on Y103A and B (treatment B) than on Y103C and D (treatment A). In the growing season, May 1 to October 31, it was nearly 0.5 in. less on Y103A and B than on Y103C and D. These changes were significant at the 5 percent and 10 percent level, respectively. Soil water which was formerly available for deep percolation was utilized by increased evapotranspiration and subsequent soil moisture recharge.

A percolation record from lysimeter site Y101 allowed a contrast of a deep rooted cover (alfalfa-brome) with a shallow rooted blue grass cover. Though the short period of record did not allow a statistical evaluation of a time trend measured annual percolation from the lysimeter with the deep-rooted cover was on the average, about 5 in. less than the percolation from the lysimeter with the shallow-rooted cover. This was a statistically significant difference. Again soil water formerly percolated was utilized by increased evapotranspiration and subsequent soil-moisture recharge.

From stage records for the ground-water observation well located in a reforested area information was obtained on the status of gravitational water under a developing farm woodlot. A trend analysis of water-surface elevations at the start of the dormant season, November 1, corrected for antecedent precipitation conditions, indicated that nineteen years after tree planting the elevation has declined by about 20 in. relative to conditions before planting. No evidence could be found of a change in water levels at the start of the growing season, May 1. This reflects the change from a shallow-rooted cover to relatively deeper rooted trees. Soil moisture is now being utilized to a greater depth and hence is being used in greater amounts. Indeed, since little recharge takes place during the latter part of the growing season, more *dormant season* precipitation is required each year for soil moisture recharge.

Paper presented at the Annual Meeting of the American Society of Agricultural Engineers at Ithaca, N.Y., June 1959, on a program arranged by the Soil and Water Division.

The authors—D. L. BRAKENSIEK and C. R. AMERMAN—are hydraulic engineers, Agricultural Research Service, USDA, Coshocton, Ohio.

Acknowledgment: The authors gratefully acknowledge the many contributions made to this study by L. L. Harrold, J. L. McGuinness, and F. R. Dreilbelbis.

*Numbers in parentheses refer to the appended references.

†A description of the management level under treatments A and B is given in Table 1.

In the following paragraphs of this paper, facilities and the study made of stream flow will be described and discussed. At Coshocton stream flow is composed of surface runoff, varying amounts of subsurface runoff and aquifer or base flows.

Facilities

For more than twenty years the Soil and Water Conservation Research Station at Coshocton, Ohio, has been collecting rainfall and runoff records on watersheds ranging in size from less than 1 acre to more than 4,000 acres. These watersheds, originally farmed by average to poor methods, according to the standards of the 'twenties and 'thirties, were subjected in the early years of the Station's history to land-use and treatment changes. The established practices are given in Table 1. In addition an area was converted to a well-managed farm woodlot. Some changes have been made in all practices as a result of generally accepted improvements in agriculture, e.g., new seed varieties, use of better fertilizers and better field equipment. Table 2 contains descriptions of land use of the study watershed in 1938 and 1957.

TABLE 1. DESCRIPTION OF MANAGEMENT LEVELS, 1947 - 57*

Item	Treatment A (Watersheds 183 and 196)	Treatment B (Watersheds 169 and 177)
Tillage	Across slope	Contour
Planting method	Entire field	Entire field or 2 to 3-acre fields; alternating strips of meadow and row crop or grain on 7.5-acre areas
Fertilization per acre		
Corn	Lime to pH 5.4 Manure 6 tons 2-12-6 — 100 lb in the row	Lime to pH 6.8 Manure 6 tons 3-12-12 — 300 lb in the row
Wheat	2-12-6 — 125 lb	3-12-12 — 300 lb Manure topdressing 4 tons
Meadow	None	0-20-20 — 200 lb on first-year meadow
Seeding rate per acre		
Wheat	2 bu	2 bu
Meadow in wheat	Timothy — 3 lb	Timothy — 3 lb
Meadow, spring	Red clover — 6 lb Alsike — 3 lb Timothy — 3 lb	Alfalfa — 6 lb Red clover — 4 lb Timothy — 3 lb

*From 1937-46 Treatment A called for 75 lb of 2-12-6 on corn and 125 lb of 2-12-6 on wheat and Treatment B called for 200 lb of 2-12-6 on corn, 300 lb of 2-12-6 on wheat, and 100 lb of 0-20-0 on second-year meadow.

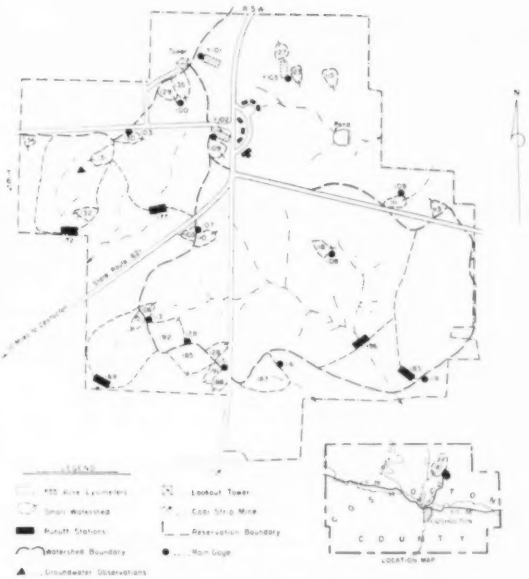

Fig. 1 Map of USDA Soil and Water Conservation and Research Station at Coshocton, Ohio

Fig. 1, a map of the station, shows the locations of the watersheds studied and pertinent flumes and raingages. Soils of the station, generally well-drained, have been described in detail in a previous publication (5). The geology of the watersheds is composed of strata of coal, limestone, sandstone, clay, and shale, giving rise to perched water tables and artesian aquifers which outcrop as springs and seeps at various elevations on the slopes. The area is unglaciated. Fig. 2 represents the present best estimate of the geologic cross section through the gaging site of the woodlot watershed 172. This cross section is typical in showing the complicated subsurface runoff flow patterns of the Coshocton area.

Method of Analysis

The main problem in evaluating a time trend in stream flow is to have an analytical procedure which will remove variability from the observed data. Only in this way can a trend, if found, be inferred as due to imposed land-use and

TABLE 2. DESCRIPTION OF 1938 AND 1957 LAND USE IN PER CENT OF TOTAL AREA FOR THE FIVE STUDY WATERSHEDS

	172		177		169		183		196	
Item	1938	1957	1938	1957	1938	1957	1938	1957	1938	1957
Woodland	29.4*	100.0†	9.1	9.8	6.2	11.7	13.1	13.8	25.2	27.7
Rotation										
across slope, no strips	0	0	47.4	0	69.3	0	42.2	50.8	45.7	38.1
contour strips	0	0	0	34.5	0	69.0	0	8.6	0	0.5
Permanent pasture	50.5	0	31.1	49.5	17.9	13.4	44.2	26.8	19.3	30.5
Idle land	20.1	0	1.8	0	0	0	0	0	2.6	0
Miscellaneous	0	0	10.6	6.2	6.6	5.9	.5	0	7.2	3.2
Area, acres	43.6		75.6		29.0		74.2		303	

*Uneven age stand of hardwoods.

†In 1939 the pasture and idle land was planted to locust, red pine, pitch pine, Virginia pine, white pine and Scotch pine seedlings and transplants. No fire, grazing or serious disease damage has occurred. No harvest or thinning has been done since planting, except in the locust plantation.

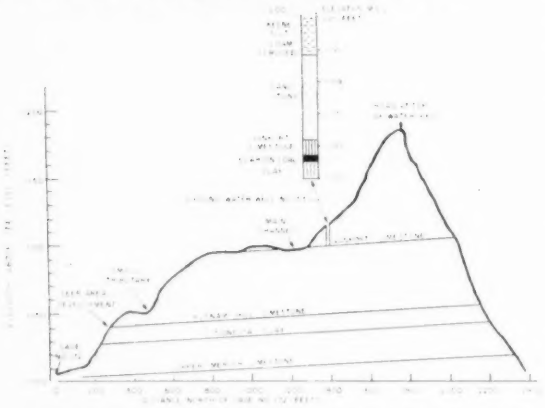

Fig. 2 Geologic profile of watershed 172 and log of well 157

treatment practices. More specifically the following qualifications must be met by a feasible analytical technique:

(a) The general level of agricultural technology is rising; i.e., yields today even on farms not practicing conservation are much higher than, say, twenty years ago. Thus any streamflow change must be evaluated as being in excess of *per se* happenings.

(b) The variations inherent in observed runoff due to year to year or season to season variations in climate must be removed. This is necessary from a statistical standpoint so as to allow a sensitive test of significance.

The above qualifications, the authors felt, could be met by the use of stream flow from an index watershed. Ideally, if the management level of the index watershed is unchanged, then the year-to-year or season-to-season variation in stream flow would essentially reflect uncontrolled climatic factors. However, this is unlikely because of inherent watershed changes. Such inherent changes would include changes in agricultural methods since the late thirties, e.g., grain harvesting changing from threshing to combining.

Only two watersheds were available for consideration in selecting the index watershed for this study as the others were changed to treatment B. Watersheds 196 and 183 were both scheduled from the start as treatment A which at that time was similar to an average prevailing practice. However, a study of the soils and erosion history of both watersheds showed that, for watershed 183, this treatment was a distinct improvement over the previous management level. In addition, almost 10 percent of the area of watershed 183 was stripcropped (Table 2). By the 'forties, crop yields on the fields of watershed 183 were in the order of 20 to 30 bu of corn per acre and about 11 bu of wheat. Treatment A has raised these yields to over 50 bu per acre for corn and 20 bu per acre for wheat. It could be expected, therefore, that stream flow from watershed 183 would be confounded with a sizeable treatment component and thus could not be used as an index watershed. Crop yields on watershed 196, which started at a higher productive level, were changed less by treatment A. Thus stream flow from watershed 196 more nearly reflects the influence of climate alone.

The analysis itself consisted of a multiple regression using the observed runoff of the remaining watersheds as the dependent variable with time and the index watershed runoff amounts, as independent variables. The time trend, then, corresponds to the partial regression coefficient of the time variable. By the usual procedures the standard deviations may be computed and significance tests of the coefficients made. For each of the four remaining watersheds (172, 177, 169, and 183), this anaylsis was performed for the growing season, May 1 — October 31, dormant season, November 1 - April 30, and the annual period May 1 to April 30. The time-trend value permitted an evaluation of the estimated change in stream flow by 1957, the last year of this study.

A graphic example of the described analysis procedure is shown in Fig. 3. The middle graph shows annual stream flow from wooded watershed 172 plotted against time. Fitting an assumed linear trend line indicates an average decline in stream flow of 0.37 in. per year with a standard deviation of 0.17 in. per year. In the lower graph the index annual stream flow (watershed 196) is plotted against time. The indicated average decline is a measure of that portion of the decline in watershed 172 which may be extraneous; however, it is not statistically significant. Also as the year-to-year variation in this plotting is similar to the lower section much of the latter variability will be removed. In the top graph is the plotting of adjusted annual stream flow of watershed 172. The reduced average trend is more nearly a measure of changes in stream flow due to the imposed land-use changes over and above what normal changes due to improved technology might have been. The reduced standard deviation indicates that much more precise measure of a change has been obtained.

Findings of Analyses

Table 3 presents the average seasonal and annual stream flow for each of the watersheds and the estimated changes in

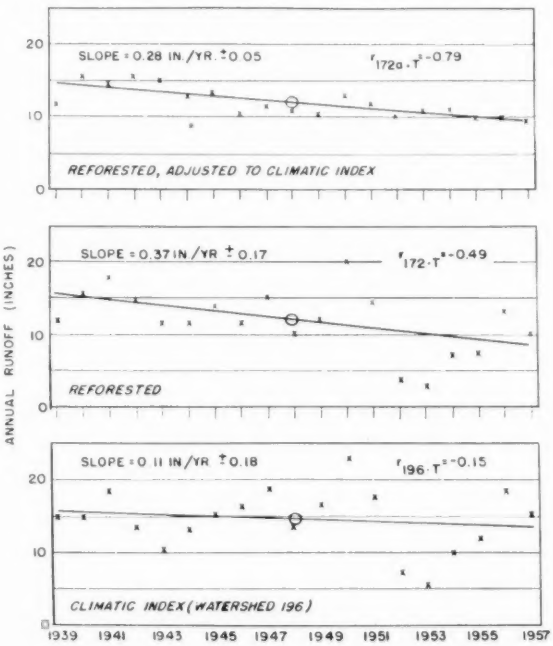

Fig. 3 Observed annual runoff from index watershed 196, wooded watershed 172, and adjusted 172 values, 1939-57

stream flow in a 19-yr period as a result of the imposed treatment.

In Table 3 particular note must be made of the probability level of significance. At the present time only the reforested watershed (172) can be considered as having a highly significant reduction in stream flow. The other watersheds at this time only show an indication of reduced stream flow. This table represents the first step in a long range and more detailed study at Coshocton pertaining to total water yield.

TABLE 3. AVERAGE STREAM FLOW AMOUNTS BY SEASONAL CHANGES* BY 1957

Watershed	Period	Average runoff, in.	Reduction by 1957†, in.	Probability Level‡
Treatment B 169	Year	6.81	1.08± 0.72	0.18
	Dormant	4.76	.72± .54	.20
	Growing	2.05	.72± .36	.07
Reforested 172	Year	12.02	5.32± .95	.0001
	Dormant	8.57	3.80± .76	.00015
	Growing	3.44	1.71± .57	.006
Treatment B 177	Year	7.89	1.62± .72	.04
	Dormant	5.79	1.26± .54	.035
	Growing	2.10	.36± .36	.35
Treatment A 183	Year	10.46	1.60± 1.20	.20
	Dormant	2.89	.60± .80	.84
	Growing	7.57	1.00± .40	.023

*All changes are negative.

For example, in 1957, the 19th year after the start of the record, the dormant season flow from Watershed 172 was 3.80 in. less than it would have been under the conditions prevailing before reforestation.

†Values after the ± sign are the standard deviation of the respective estimates.

‡Probability level at which the indicated reduction is significant and not due to pure chance.

Qualifying Considerations

It should be pointed out that the indication of time changes in stream flows may be interpreted as due to land-use and treatment practices by inference only. By nature of the analysis all extraneous factors giving rise to trends have been at least partially removed. It would seem unlikely that some unknown factor other than the imposed practices would be acting on all watersheds except 196. Thus, with a high degree of certainty any significant changes are assumed to be due to land-use and treatment practices.

The fact that the watersheds of this study are upland unglaciated watersheds is an important point in the interpretation of results. For the Coshocton experimental area, there is a tendency for seasonal and annual stream flow amounts, expressed as depth over the surface area, to increase as watershed area increases. The indication is that as area increases, the main stream channel cuts through lower and lower aquifers which then contribute to stream flow. Thus as mentioned earlier, some upland infiltration and subsequent percolation may be picked up at downstream sites. Depending upon the location of each gaging station varying amounts of groundwater outflow may leave the particular watershed to appear as downstream flow. From geologic and duration of flow considerations it appears that watersheds 169 and 177 exhibit the weakest base flow components. Hence more groundwater flow is bypassing the gage. *Study of larger sized watersheds or complete water balances on the study watersheds are required before off site effects of land use and treatment can be evaluated.*

It also must be kept in mind that the reductions were computed on the basis of an assumed linear time trend. This was because there were no records of length prior to establishment of treatments and the collection of data has not progressed for a long enough time to develop a curvilinear trend.

Discussion of Findings

Complete establishment of an accepted farm woodlot cover had a substantial effect on stream flow (Table 3). Treatment B, as described in this paper, on the cultivated watersheds had a smaller effect and the statistical significance was generally low. Watershed 183, treatment A, exhibited a reduction in stream flow. Examination of early station records indicated that this watershed was quite run down at the beginning of the study period. The subsequent imposition of treatment A, then, constituted an "improved" farming system relative to previous practices.

It is interesting and, perhaps at first glance, surprising that a considerable portion of the annual reduction occurred during the dormant season — the season of minimum evapotranspiration. This may be explained by the previous observation that since little recharge to root-zone soil moisture takes place during the latter half of the growing season, more dormant season precipitation is required each year to accomplish that recharge.

Estimated changes in the volumes of stream flow during periods of high flow and estimated reductions in peak rates of flow (to be reported in a forthcoming Coshocton bulletin) indicate an increased infiltration potential and ties in with one of the earlier developed concepts. In addition a reduction was found in the volume of runoff occurring as low flows for watersheds 183 and 172, which exhibit considerable base flow. This was also borne out from a study of base-flow recession curves, also reported in a forthcoming Coshocton bulletin. Thus the evidence would seem to be that a lesser amount of groundwater is becoming base flow. Indirectly then this ties in with the lysimeter and ground water results indicating a reduced amount of soil water available for deep percolation.

In general, the concepts presented earlier and the evidence of their validity from lysimeter, groundwater and small, single-cover watershed data seemed to have been borne out by the analysis of the set of five small, mixed cover watersheds.

It became apparent that the initial condition of a watershed and the management level imposed on it interact to give differing responses. Hence, a quantitative scale needs to be developed for measuring these two items. This would facilitate the application of future findings to other areas.

Summary

Almost 20 years of hydrologic records are available from treated watersheds located on the Soil and Water Conservation Research Station near Coshocton, Ohio. Two-treatment levels were imposed on cultivated watersheds and one watershed was converted to a complete farm woodlot. Obviously the results of this study are only meaningful to upland areas similar to those at Coshocton and which experience a similar climate.

The technique of this study evaluated the change in streamflow by the year 1957 by utilizing a computed time trend of assumed linear form over the period of record.

(Continued on page 167)

Equipment and Labor Requirements for Storing and Feeding Silage

A. T. Hendrix
Member ASAE

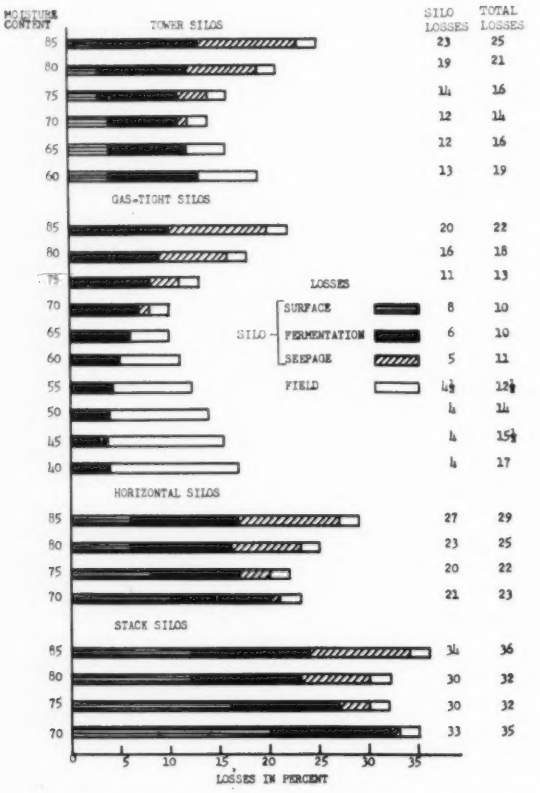

Fig. 1 Effect of moisture content on silage dry matter losses

THE first silo in the United States was constructed in Maryland in 1876 for preservation of corn forage as silage. By 1900 there were an estimated 100,000 silos in the United States, and the 1950 Census reported 679,750 silos in use. Of these, 614,027 were tower-type silos, and 65,723 were of the pit or trench type. The use of the trench silo in the United States was revived shortly after World War I, but it has been only within the last decade or so that the trench silo and grass silage have become increasingly popular. In the South and West, trench silos provide a larger proportion of the total silage storage capacity than in other areas of the country.

During the period 1939-55, total production of silage in the United States nearly doubled—from less than 38 million tons to about 73 million tons in 1955. During this period the percentage rate of increase in production of grass silage exceeded that of either corn or sorghum silage. In Table 1 are shown productions, average yields, average unit values, and other information relative to the three principal kinds of silage in the United States, as obtained from agricultural statistics of the U.S. Department of Agriculture.

Although production of grass and sorghum silages increased rapidly in recent years, corn still provided about 74 percent of the combined tonnages of corn, sorghum and grass silages produced in the United States in 1955.

Storage Methods and Silage Costs

After a forage crop has been produced, the cost of silage made from that crop is affected by several factors in addi-

Paper presented at a meeting of the Southeast Section of the American Society of Agricultural Engineers at Atlanta, Ga., February 1956, revised September 1959.

The author—A. T. HENDRIX—is agricultural engineer, (AERD, ARS) USDA, Athens, Ga.

*Numbers in parentheses refer to the appended references.

TABLE 1. PRODUCTION, YIELDS, HARVESTING METHODS AND STORAGE OF SILAGES IN THE UNITED STATES

Crop	Year	Production: Tons	Production: Approximate percentage of corn, sorghum, and grass silage	Production: Tons per acre	Value, dollars per ton	Harvested with: Field forage harvester, percent	Harvested with: Stationary cutter, percent	Type of silo storage: Tower, percent	Type of silo storage: Trench bunker, percent	Type of silo storage: Temporary, percent
	1939	32,533,463	87.66	7.33	3.95					
Corn	1949	38,006,618	88.65	8.76	6.77	32*	68*			
	1955	53,078,000	73.90	7.61	7.58	84	16	70	23	7
	1939	4,280,110	11.53	4.84	3.96					
Sorghum	1949	3,368,308	7.86	6.99	7.05	54*	46*			
	1955	9,402,000	13.10	5.50	8.72	93	7	23	70	7
	1939	298,851	0.81	5.11	4.34					
Grass	1949	1,494,787	3.49	5.03	8.23	39*	61*			
	1955	9,335,000	13.00	5.80	6.54	93	6	75	19	6
All silage	1955	72,922,000				87	13	63.9	28.4	7.7

*For the year 1948.

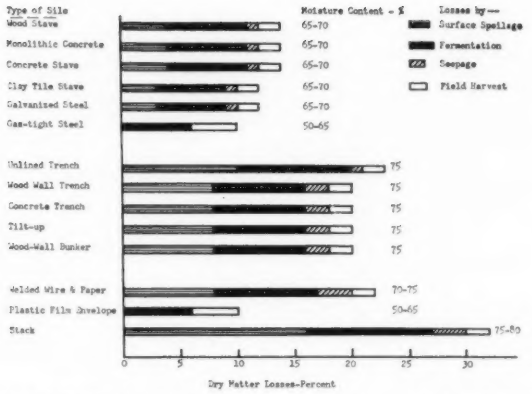

Fig. 2 Estimated average minimum dry matter losses in silage storage

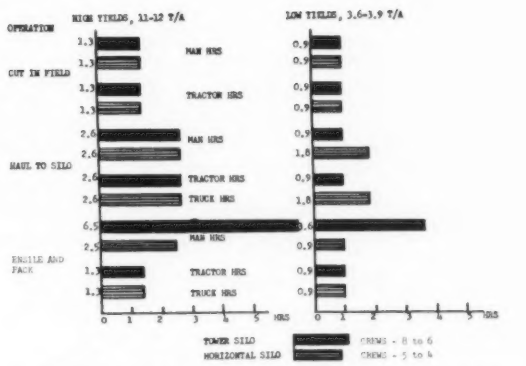

Fig. 3 Effect of type of silo and crop yield on power and labor requirements for harvesting forage for silage (row crop)

tion to storage method. The storage used not only affects the direct cost of storage but also contributes to variations in methods and costs of harvesting, in storage losses, and in methods and costs of outhandling and feeding. It is therefore necessary to give consideration to all these operations in order to arrive at cost comparisons of different methods of silage storage.

Considerable effort has been made by several investigators to obtain representative and realistic values for various input factors in forage harvesting for silage. This type of information is, however, still rather limited, and reported values necessarily vary. Because of this and because of the nature of the activities involved, it is not possible to give specific values to the various costs involved in the several operations performed in harvesting forage crops.

Similar situations exist in regard to direct silo costs, to spoilage losses, and to outhandling and feeding of silage. It must therefore be understood that the estimated costs arrived at in the following discussion are comprised of separate estimates of the several operations involved in the over-all silage production, storage, and handling process, and that each of these is subject to rather wide variations, both in theoretical consideration and in practice. It should also be realized that the several input factors which affect and make up total costs vary considerably from farm to farm, from locality to locality, and from one time to another.

Types and Costs of Silos

When the silo alone is considered, the cost of the structure may vary over a rather wide range. The type of silo, material of which it is constructed, quality of materials used, distance from point of manufacture, whether delivered or picked up, labor and other costs of erection provided, accessories furnished (such as roof, chute, ladder, loading platform, etc.), all are items which influence final structure cost.

There is perhaps no other farm structure which has so much structural variations as silage-storage structures. Many types and designs of silos have been devised and several are now in use. A variety of materials have been and are now being used in silo construction. Considerable time and effort are now being devoted to use of new materials and to development of new methods and improved procedures for silage production, preservation, and storage.

The more commonly used silos may be classified for purposes of cost comparisons somewhat as follows:

(A) Tower Silos

1. Wood stave
2. Monolithic concrete
3. Concrete stave
4. Clay tile stave
5. Galvanized steel
6. Gas-tight steel

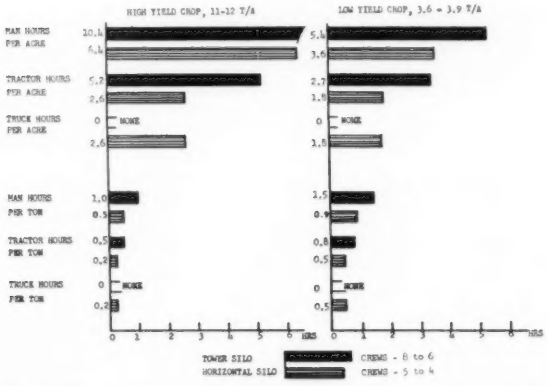

Fig. 4 Effect of type of silo on power and labor requirements for filling (all operations)

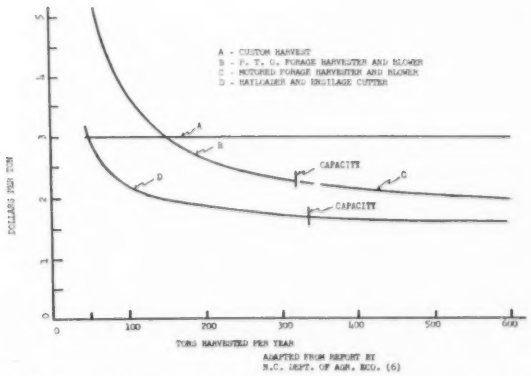
A - CUSTOM HARVEST
B - P. T. O. FORAGE HARVESTER AND BLOWER
C - MOTORED FORAGE HARVESTER AND BLOWER
D - HAYLAGER AND ENSILAGE CUTTER
DOLLARS PER TON
CAPACITY
CAPACITY
TONS HARVESTED PER YEAR
ADAPTED FROM REPORT BY N.C. DEPT. OF AGR. ECO. (6)

Fig. 5 Estimated cost per ton when harvesting grass silage by alternative processes

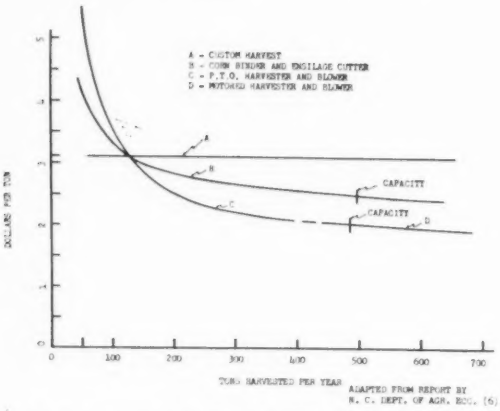
A - CUSTOM HARVEST
B - CORN BINDER AND ENSILAGE CUTTER
C - P.T.O. HARVESTER AND BLOWER
D - MOTORED HARVESTER AND BLOWER
CAPACITY
CAPACITY
DOLLARS PER TON
TONS HARVESTED PER YEAR
ADAPTED FROM REPORT BY N. C. DEPT. OF AGR., ECO. (6)

Fig. 6 Estimated cost per ton when harvesting corn silage by alternative processes

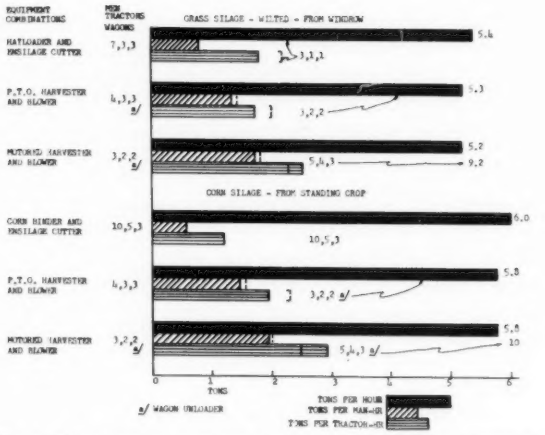

Fig. 7 Labor, power and equipment requirements for harvesting silage

(B) Horizontal Silos

1 Trench, unlined
2 Trench, concrete floor, wood walls
3 Trench, concrete floor and walls
4 Trench or bunker, tilt-up concrete walls
5 Bunker, concrete floor, wood walls

(C) Miscellaneous Silos

1 Snow fence or welded wire, paper lined
2 Plastic film envelope
3 Stack or pile, with or without plastic film cover

The principal items which make up directly the annual cost of any silage storage are: *(a)* depreciation, *(b)* maintenance and repair, *(c)* interest on investment, *(d)* taxes, *(e)* silage losses in storage, and *(f)* net cost of preservative, if used. For comparison of different methods of silage storage, to these must be added the cost of forage harvesting (including field losses) and costs of outhandling and feeding silage, insofar as these are affected by method of storage and type of silo used.

An effort has been made here to obtain and summarize representative average values of each cost item, realizing that each of the values listed is subject to wide variation under differing situations.

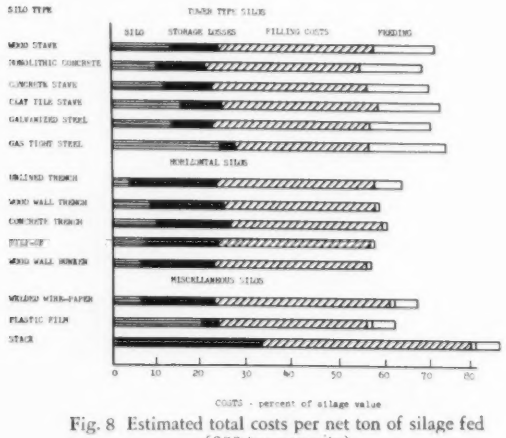

Fig. 8 Estimated total costs per net ton of silage fed (200-ton capacity)

Harvesting Forages for Silage

Mechanization of forage harvesting has advanced rapidly in recent years (Table 1). Labor requirements have been reduced where mechanization has been effected, but unfortunately mechanization has not always achieved greater economy. The requirement for greater investment in machinery and equipment often has tended to maintain or even increase costs of harvesting. With complete mechanization, using present procedures and equipment, relatively greater tonnages of forage must be processed to obtain economical performance.

Magee (4)*, in a report of a field study conducted on 85 Texas farms with silos, stated that a crew of 5 men with two tractors and two trucks per day harvested 8 acres yielding 12 tons per acre when filling horizontal silos. Eight men with four tractors were required for the same harvesting capacity for tower silos. Lower yielding crops also required less labor for harvesting when the material was ensiled in a horizontal silo. Comparisons of harvesting requirements as reported in this study, and as related to type of storage are

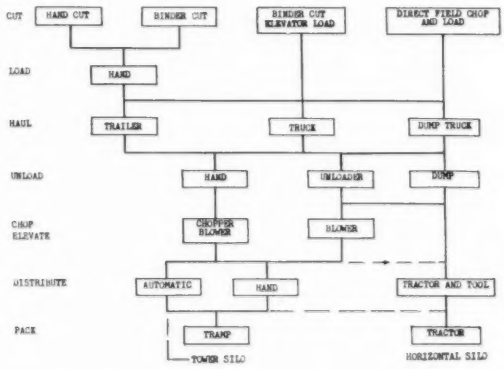

Fig. 9 Combined flow charts of operations in harvesting corn silage

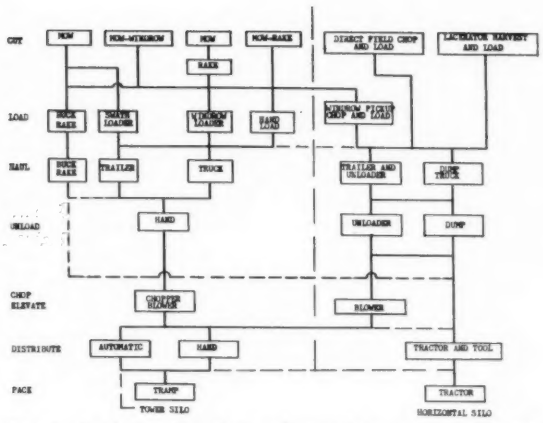

Fig. 10 Combined flow charts of operations in harvesting grass silage

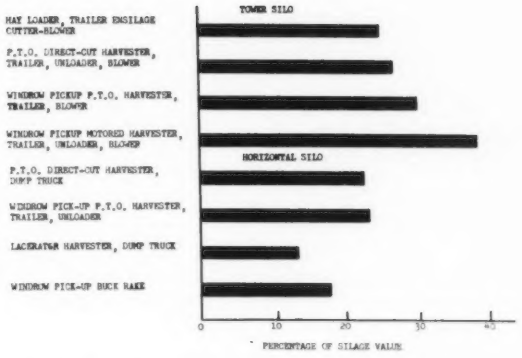

Fig. 11 Estimated costs of harvesting grass for silage by different equipment combinations (based on observed machinery requirements): Labor, 60¢ per hour; tractor, 88¢ per hour; and 100 hours machinery use per year

shown in Figs. 3 and 4. For tower silos, requirements ranged from 1.5 man-hours and 0.8 tractor-hours per ton for low-yield crops (3.6 tons per acre) to 1.0 man-hour and 0.5 tractor-hours per ton for high-yield crops (11 tons per acre). Comparable data for horizontal silos showed 0.9 man-hours, 0.5 tractor-hours, and 0.5 truck-hours per ton for low-yield crops (3.9 tons per acre) and 0.5 man-hours, 0.2 tractor-hours, and 0.2 truck hours for high-yield crops (12 tons per acre). In each case crews averaged about 50 percent larger when filling tower silos than when filling horizontal silos.

At the South Dakota Station (5) harvesting costs were reported as $2.07 per ton of material ensiled in horizontal silos, $2.28 for tower silos (except a gas-tight steel which was reported as $2.18 per ton) and, because of extra labor required, $2.40 per ton ensiled in stack silos.

In Table 2 are shown estimated initial construction and annual costs per ton of storage capacity for various types of silos. The values shown are for silo costs and storage losses only on a gross storage capacity basis. To obtain total costs per ton of silage fed (net ton), the cost of green forage crop, the cost of harvesting and filling, and of outhandling and feeding must be added to direct silo costs and the appropriate items of cost converted to a net ton basis.

An important item in determining annual cost is the useful life of silos. While there is great variation in this the values shown in Table 2 are believed to be fairly representative averages of silos well constructed and maintained.

Silage Losses

An important item of silage storage cost is silage loss. There is a voluminous literature on losses of nutrients under various conditions and methods of forage preservation. According to Shepherd *et al* (1) storage losses in silos may be divided into *(a)* seepage losses, *(b)* fermentation losses and *(c)* top spoilage. Because of relatively high surface losses in horizontal and stack silos, the total storage losses are usually higher than those in tower silos. However, where properly filled, packed and covered, surface losses in horizontal silos can be kept to a minimum.

TABLE 2. ESTIMATED COST OF SILOS PER TON CAPACITY

Type of silo	Average initial cost per ton capacity, 14 x 30 ft 100 tons	16 x 40 ft 200 tons	Estimated life, years	Annual cost per ton[1], percent of initial cost	Annual cost per ton capacity, (silo only), percent of initial cost	Estimated silage losses, percent	Annual silo costs per gross ton[2] 100 tons	200 tons
	Dollars per ton[3]						percent of initial cost	
Tower								
Wood stave	12.00	10.00	25	8.7	8.7	14	14.5	15.7
Monolithic concrete	12.00	9.00	35	7.4	7.4	14	13.2	15.2
Concrete stave	13.00	10.00	30	7.8	7.8	14	13.2	14.8
Clay tile stave	22.50	17.50	45	6.5	6.0	12	9.2	9.4
Galvanized steel	17.50	13.50	40	6.7	6.7	12	10.1	11.1
Gas-tight steel	32.00	25.10	40	7.0	7.0	5	7.8	8.0
Horizontal								
Unlined trench	1.00	0.80	5	26.0	2.6	23	14.1	17.0
Wood wall trench	6.00	4.50	15	11.5	11.5	20	28.1	33.8
Concrete trench	7.60	7.00	25	8.5	8.5	20	22.0	22.9
Tiltup horizontal	6.00	5.20	25	8.5	8.5	20	25.2	27.7
Wood wall bunker	7.50	5.00	20	9.7	9.6	20	23.0	27.6
Miscellaneous silos								
Welded wire, paper	1.00	0.80	3	36.8	4.7	20	147.0	172.0
Plastic film envelope	1.50	1.40	1	103.5	10.5	5	121.0	121.0
Stack	0.05	0.04		103.5	100.0	33	3400.0	4200.0

[1]Includes depreciation, maintenance, interest on investment, and taxes.

[2]Includes spoilage loss with green forage crop at $5.00 per ton.

[3]Based on estimated 1955 costs with average silage value $7.60 per ton.

. . . Storing and Feeding Silage

Rauchenstein (2) states that up to 10 percent of total dry matter can be lost in seepage. Gordon *et al* (3) reported that at Beltsville in 1954 seepage losses in tower silo tests were a minimum of 11 percent of the dry matter stored. Seepage losses can be reduced by wilting of forage, or by ensiling material of not over 70 percent moisture. This, however, tends to increase surface losses and is not usually recommended for either horizontal or stack silos unless the storages are properly covered.

Total storage and field-harvesting losses of silage as related to moisture content of ensiled material are shown for four silo types in Fig. 1 (2). In Fig. 2 are shown estimated average minmum losses of silage when stored in silos of several types under reasonably good practices.

Silage Preservatives

The effectiveness and economy of using preservatives with grass silage are in question, especially the economy. Investigators at the Beltsville Station, USDA (3) concluded that the final quality of an untreated silage is to a large extent unpredictable, and therefore the quality improvement resulting from use of a silage preservative is to the same extent unpredictable. Various other investigators have found that cost of preservatives were not always returned by increased savings. The economy or necessity of preservative use apparently has not been established. Consequently in this discussion no part of silage storage costs is charged to use of preservatives.

Field studies and analysis by Kline and McPherson (6) of forage harvesting labor, machinery, and power requirements and costs have been reported. Figs. 5 and 6, which were adapted from their report, show graphically the relation between annual cost per ton of harvesting forage and the tonnage processed, using various combinations of harvesting equipment, and with selected forages. Also in Fig. 7 are shown forage-harvesting capacities, labor and power efficiencies of various equipment combinations, and crew sizes.

The values reported by the South Dakota station (5) for forage harvesting, because they appear to be representative and because they reflect the effect of storage method, are used in the silage costs summary shown in Fig. 8.

Outhandling and Feeding Silage

Outhandling and feeding practices (for both equipment and labor) vary from manual to completely automatic and from hand feeding in mangers to self-feeding directly from storage.

DeLong and Schneider (5) reported 0.1 to 0.3 man-hours per ton required for unloading from tower silos with unloaders as compared with 0.2 to 0.4 man-hours for unloading horizontal and stack silos with tractor scoop. Hand feeding required 1.1 man-hours while self-feeding from horizontal and stack silos required only 0.06 and 0.064 man-hours per ton, respectively. Rauchenstein (2) states that one-half to one man-hour per day was required for feeding silage and hay with a 30-cow unit. In tests conducted at the South Dakota station, 33 times as much labor was required for hand feeding from tower silos as was required for self-feeding from horizontal silos. Ronning (7) reported that ½ hr or less labor is required each week to 10 days to service the horizontal silo where self-feeding is practiced. Peterson (8) states that in preliminary feeding trials at the Nebraska station no significant differences were found in milk production between cows self-fed from horizontal silos and control cows. The "boss cow" factor apparently was of no consequence in these observations.

The silo unloader may save about ½ man-hour per day with a herd of 40 cows. A feed cart is estimated to cut time required to about one-half that required in hand feeding. Conveyors for automatic feeding have been constructed in various localities. At the North Dakota station a revolving circular feeder 14 ft in diameter was constructed at a reported cost of $350. Special unloading wagons emptying into continuous outdoor bunks have been developed for silage feeding and can be unloaded at rates as high as one ton per minute.

Schneider (9) in studies comparing conveyor and hand feeding of dairy cows at the Vermont station reported slightly more than one-half of hand feeding time was required for conveyor feeding. Time in minutes per cow was: conveyor feeding, 2.3; hand feeding by cart, 3.8, and hand feeding by basket, 4.7. Retail cost of conveyor system was estimated at approximately $470. Less than 4 kw-hr were used per month to power the conveyor.

By using available information from the above and from other studies, estimates were made of outhandling and feeding costs by different methods and under different situations. The resulting values are as follows:

Outhandling and Feeding Method (One ton of silage per day; labor at 60¢ per hr)	Cost estimate—percentage of silage value
Hand unload from tower silo and hand feed by basket	16.6
Hand unload from tower silo and use feed cart to mangers	14.2
Tower silo unloader and feed cart	13.8
Gas-tight silo, unloader, and feed cart	17.4
Gas-tight silo, unloader, hand feed by basket	19.7
Silo unloader and conveyor feeder	14.4
Self-feed from horizontal silo	1.1
Horizontal silo with tractor scoop to bunkers	6.3

Economies in Forage Harvesting and Storage

In the foregoing discussion of costs involved in harvesting, storing and feeding silage, various items were included in the cost estimates. In review, it was apparent that higher initial costs of some storage structures were mostly returned in reduced storage losses. In order to effect economies in the over-all silage production process, it would appear that the more promising opportunities are in reducing costs in the harvesting operations and in reduction of losses in storage, combined with selection of lower cost silage storages and feeding methods.

Forage harvesting and silage making is a series of operations. One method of estimating and comparing costs is to visualize the entire process as a series of "unit operations," with each such operation having fairly definite, though variable, equipment, power and labor requirements. Unit operations can be selected as desired, or needed, to fit into any given situation in order to obtain optimum results. When the selected operations are combined in order a "flow chart" results, and by using cost estimates of each unit

operation an over-all estimate of the total cost can be obtained. Because of the complexity and interrelationships of factors involved, no one flow chart can be selected to best fit all conditions. There are several combinations of unit operations which might appropriately be chosen to be effective and reasonably economical in any specific situation. Studies have been made which allow estimates of input for each unit operation.

In Fig. 9 are shown various unit operations involved in harvesting corn forage for silage. Fig. 10 shows similar operations in harvesting grass forage. It is apparent that several unit operations are common to both harvesting processes, and can in some instances be accomplished by the same equipment at comparable or equal cost.

By selecting desired unit operations in suitable combination to achieve the desired harvesting-procedure estimates and comparisons of harvesting costs by different combinations can be made. The results obtained, of course, can be no better than the input factor information on which the separate estimates are based. Unfortunately available data appropriate to this type of approach are not plentiful.

When using this procedure to arrive at estimated over-all costs with different equipment combinations the results indicate some possibilities for increased economies, particularly when total tonnages of forage processed are relatively small. A comparison of some presently used and some possible procedures is shown in Fig. 11. Other combinations of equipment and unit operations could also be used.

Silage losses, especially in horizontal silos, can be reduced substantially below the values given in this discussion. Methods and materials now available and in limited use are effective and economical in reducing surface spoilage to a minimum. By careful selection of least-cost combinations of forage harvesting, storing, and feeding silage, it should be possible to achieve efficient and economical over-all results. For example, where tonnage of grass forage to be harvested for silage is within the capacities of the separate-unit facilities the following procedure might be used:

(a) Harvest forage by lacerator-harvester

(b) Store in plastic-covered stack, trench or bunker silo

(c) Self-feed or bunker feed with tractor scoop.

Indicated over-all cost of the above combination of operations is substantially lower than estimates based on most commonly used procedures.

Summary

Production of silage in the United States reached about 73 million tons in 1955. Costs involved in storage of silage include not only the storage itself but also harvesting and handling costs insofar as these are affected by the storage method used.

Silage-storage structures vary widely in design features and in initial costs of construction per unit capacity. Effectiveness in preservation of forage varies less widely. Silage loss in storage is an important item of annual cost. High initial unit cost of silos is to a large extent offset by longer life, and by more effective preservation of forage. Recent developments with lower-cost storages have improved their storage efficiency.

Equipment for mechanization of harvesting and handling forage is now in extensive use. Mechanization frequently requires processing of relatively higher tonnage of forage to achieve over-all economy.

Numerous factors are involved in determination of silage storage costs. Because of the interdependence of the various operations involved, it is necessary to include over-all operations in estimating costs, which vary from locality to locality, from farm to farm, and from one time to another.

By giving careful consideration to each operation in the over-all process of silage production, storage and feeding, there appears to be opportunities for economies which could be achieved on a practical basis. The promise justifies the continued interest and effort which exists in this area of work.

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. . . Evaluating Effect of Land Use

(Continued from page 161)

An index based on the runoff from watershed 196 enabled a sensitive test of significance for the estimated change and also insured that trends due to climatic elements and the general improving of agricultural technology were eliminated.

Establishment of a farm woodlot (watershed 172) greatly reduced the annual stream flow amount from this upland area, 5.32 in. by the nineteenth year. This finding is in line with other forest management studies, which, however, were studied for the deforestation situation, (Hoover, 1944) and (Lieberman and Hoover, 1951).

Changes in stream-flow amounts from agronomic areas, watersheds 169, 177, and 183, were smaller, generally reduced slightly more than 1 in. by the nineteenth year. At this time only a low level of statistical significance can be placed on these changes as compared to the change under reforestation.

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Relations Between Air and Solid Particles Moving Upward in a Vertical Pipe

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Combining air-movement measurements with analytical description of air-solid interactions

ONE portion of the power input to an impeller blower is absorbed in producing air movement in the delivery pipe. This air movement, then, has been thought to influence the movement of solid materials. However, it has been difficult to measure air movement under operating conditions because the solid material interferes with the measuring instruments.

In this study it is attempted to combine air-movement measurements (no solid material) with an analytical description of air-solid interactions so that pressures and rates of air movement, as well as the influences of the air on the solid material, may be determined.

Several researchers have studied qualitative considerations in the relative effects of air and material movements in the pipe from a forage blower (1, 2, 6, 7)*, and Kampf (4) has proposed an analytical approach to the matter. Negative pressures observed at the pipe inlet (2, 7) indicated that under some conditions the "blower" might actually be acting as a throttle.

Analyses

Once a particle has entered the pipe, its movement soon becomes vertical. If the particle has any upward velocity, the majority of conditions in which the particle will exist can be analytically considered as one of the following three cases:

Case 1. The particle is moving upward faster than the airstream.

Case 2. The airstream is moving upward faster than the particle but at a relative velocity less than the suspension, or terminal, velocity of the particle.

Case 3. The airstream is moving upward faster than the particle but at a relative velocity greater than the suspension velocity of the particle.

The suspension velocity concept is used because of its convenient properties, though any quantity of material, it is realized, has a range of suspension velocities.

In the following analyses it is convenient to use the relationship that the force of an airstream on a particle is proportional to the square of the relative velocity, although at very low velocities this may not apply exactly. The velocity of the air is considered essentially constant throughout the length of the pipe, because of the very small pressure changes and the constant diameter. Frictional and normal forces between the particle and the pipe wall are not considered.

The symbols used are as follows:

V_r = relative velocity of the particle in the airstream
V_s = suspension velocity or terminal velocity
m = mass
g = acceleration of gravity
t = time
V_a = velocity of airstream
H_r = height relative to original position in airstream
H_t = height relative to the original point in the pipe.

Any symbol followed by the subscript O indicates the condition at $t = O$.

Case 1 (particle moving upward faster than air stream): Here V_r is considered to be positive.

The forces on the particle consist of an upward force due to the loss of upward relative velocity (inertia force), a downward drag force due to the airstream moving relatively downward, and a downward force due to gravity, giving the equation:

$$-\frac{m\,dV_r}{dt} = \frac{mg\,V_r^2}{V_s^2} + mg \qquad [1]$$

which resolves to

$$-t = \frac{V_s}{g}\left(\tan^{-1}\frac{V_r}{V_s} + C\right) \qquad [2]$$

When $t = O$, $V_r = V_{ro}$, so $C = -\tan^{-1}\frac{V_{ro}}{V_s}$, giving

$$t = \frac{V_s}{g}\left(\tan^{-1}\frac{V_{ro}}{V_s} - \tan^{-1}\frac{V_r}{V_s}\right) \qquad [3]$$

$H_x = \int t\,dV_r$ = the distance (relative to the airstream) that the particle has moved in the airstream from the position it would have been in if its relative velocity had been fixed at any value of V_r less than V_{ro} (Fig. 1). An initial solution is:

$$H_x = \frac{V_s}{g}\left[V_r\left(\tan^{-1}\frac{V_{ro}}{V_s} - \tan^{-1}\frac{V_r}{V_s}\right) + \frac{V_s}{2}\,\mathrm{Ln}\left(V_s^2 + V_r^2\right) + C\right] \qquad [4]$$

When $H_x = O$, $V_r = V_{ro}$, $C = -\frac{V_s}{2}\,\mathrm{Ln}\left(V_s^2 + V_{ro}^2\right)$, then

$$H_x = \frac{V_s}{g}\left[V_r\left(\tan^{-1}\frac{V_{ro}}{V_s} - \tan^{-1}\frac{V_r}{V_s}\right) + \frac{V_s}{2}\,\mathrm{Ln}\left(\frac{V_s^2 + V_r^2}{V_s^2 + V_{ro}^2}\right)\right] \qquad [5]$$

in which the direction of H_x is considered relative to V_r as viewed from the particle and is really an upward movement

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*Numbers in parentheses refer to appended references.

of the particle in the airstream as denoted by a negative value for H_x in this case.

H_t is the total height of the particle above any fixed reference point. $H_t = t(V_a + V_r) - H_x$ in which H_x is negative and V_r is positive for this case as explained above.

$$V_r t = \frac{V_s}{g}\left[V_r\left(\tan^{-1}\frac{V_{ro}}{V_s} - \tan^{-1}\frac{V_r}{V_s}\right)\right] \text{ ; therefore}$$

$$H_t = t(V_a) - \frac{V_s}{g}\left[\frac{V_s}{2}\,Ln\left(\frac{V_s^2 + V_r^2}{V_s^2 + V_{ro}^2}\right)\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [6]$$

Case 2 (airstream moving upward faster than particle) *($V_r < V_s$):* Here V_r is negative for its direction is opposite to that of V_r in Case 1.

Forces on a unit mass particle are:

$$\frac{dV_r}{dt} = g\left(\frac{V_r^2}{V_s} - 1\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [7]$$

which resolves to

$$-t = \frac{V_s^2}{g}\left(\frac{1}{V_s}\tanh^{-1}\frac{V_r}{V_s} + C\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [8]$$

When $t = 0$, $V_r = V_{ro}$, $C = \frac{-1}{V_s}\tanh^{-1}\frac{V_{ro}}{V_s}$, giving

$$-t = \frac{V_s}{g}\left(\tanh^{-1}\frac{V_r}{V_s} - \tanh^{-1}\frac{V_{ro}}{V_s}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [9]$$

$$H_x = \int -t\, dV_r = \frac{V_s}{g}\left[V_r\left(\tanh^{-1}\frac{V_r}{V_s} - \tanh^{-1}\frac{V_{ro}}{V_s}\right) + \frac{V_s}{2}\,Ln\,(V_s^2 - V_r^2) + C\right] \quad . \quad [10]$$

When $H_x = 0$, $V_r = V_{ro}$, $C = \frac{-V_s}{2}\,Ln\,(V_s^2 - V_{ro}^2)$, then

$$H_x = \frac{V_s}{g}\left[V_r\left(\tanh^{-1}\frac{V_r}{V_s} - \tanh^{-1}\frac{V_{ro}}{V_s}\right) + \frac{V_s}{2}\,Ln\left(\frac{V_s^2 - V_r^2}{V_s^2 - V_{ro}^2}\right)\right] \quad . \quad . \quad [11]$$

where the direction of H_x is considered relative to V_r as viewed from the particle and is a downward movement in the airstream in this case (Fig. 1).

$$H_t = (V_a + V_r)t + (H_x)$$

V_r is negative in this case.

$$-V_r t = \frac{V_r V_s}{g}\left(\tanh^{-1}\frac{V_r}{V_s} - \tanh^{-1}\frac{V_{ro}}{V_s}\right) \text{ , so}$$

$$H_t = V_a t + \frac{V_s^2}{2g}\,Ln\,\frac{(V_s^2 - V_r^2)}{(V_s^2 - V_{ro}^2)} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [12]$$

Case 3 (airstream moving upward faster than particle) *($V_r > V_s$):* Here, also V_r is negative, for its direction is opposite to that of V_r in Case 1.

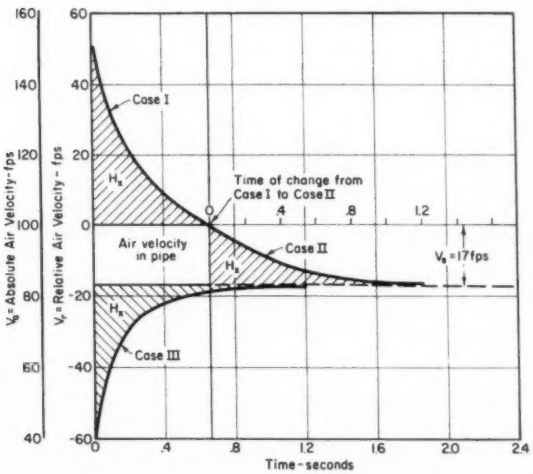

Fig. 1 Examples of particle velocity changes with time

Forces on a unit mass particle are:

$$\frac{dV_r}{dt} = g\left(\frac{V_r^2}{V_s^2} - 1\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [13]$$

which resolves to

$$t = \frac{V_s}{g}\left(-\coth^{-1}\frac{V_r}{V_s} + C_2\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [14]$$

When $t = 0$, $V_r = V_{ro}$, $C_2 = \coth^{-1}\frac{V_{ro}}{V_s}$ giving

$$t = \frac{V_s}{g}\left(\coth^{-1}\frac{V_{ro}}{V_s} - \coth^{-1}\frac{V_r}{V_s}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [15]$$

$$H_x = \int t\, dV_r = \frac{V_s}{g}\left[V_r\left(\coth^{-1}\frac{V_{ro}}{V_s}\coth^{-1}\frac{V_r}{V_s}\right) - \frac{V_s}{2}\,Ln\,(V_r^2 - V_s^2) + C\right] \quad . \quad [16]$$

When $H_x = 0$, $V_r = V_{ro}$ so $C = \frac{V_s}{2}\,Ln\,(V_{ro}^2 - V_s^2)$, then

$$H_x = \frac{V_s}{g}\left[V_r\left(\coth^{-1}\frac{V_{ro}}{V_s} - \coth^{-1}\frac{V_r}{V_s}\right) + \frac{V_s}{2}\,Ln\,\frac{(V_{ro}^2 - V_s^2)}{(V_r^2 - V_s^2)}\right] \quad . \quad . \quad [17]$$

$H_t = (V_a + V_r)t - H_x$, where V_r is negative in this case

$V_r t = \frac{V_s V_r}{g}\left[\coth^{-1}\left(\frac{V_{ro}}{V_s}\right) - \coth^{-1}\left(\frac{V_r}{V_s}\right)\right]$, so

$$H_t = V_a t - \frac{V_s^2}{2g}\,Ln\left[\frac{(V_{ro}^2 - V_s^2)}{(V_r - V_s)}\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [18]$$

Fig. 1 illustrates these relationships. The results of these analyses may be used as follows:

If air velocity *(V_a)*, suspension velocity *(V_s)*, and initial relative particle velocity *(V_{ro})* are known or assumed, various values of t may be chosen and values of V_r computed and plotted, as in Fig. 1. Such a plot permits computation and construction of a plot of H_t vs. t (Fig. 2). Information combined from these two plots is sufficient to define the velocity of exit and the time of pipe traverse for any given set of conditions.

As the particle moves through the pipe, particle velocity is influenced by two factors: (1) the product of the acceleration of gravity and the time during which it acts and (2) the force exerted between the air column and the particle. The over-all change in particle velocity can be determined by using the previously mentioned plots. These plots also give the value of t, which, multiplied by the gravitational constant, gives the velocity change due to gravity.

The difference between the velocity change due to gravity and the over-all velocity change is due to the force between the particle and air column. This difference *($\triangle V_f$)* is related to the force in question *(F)* by $m\triangle V_f = \int F\, dt$ giving

$$\frac{dm}{dt}(\triangle V_f) = F$$

where $\frac{dm}{dt}$ = rate of mass flow and F = the force of the air column on the particle and (temporarily neglecting pipe friction) the opposing force required to maintain a given velocity of the air column.

The force *(F)* divided by the pipe area is, then, the pressure difference between the top and bottom of the pipe.

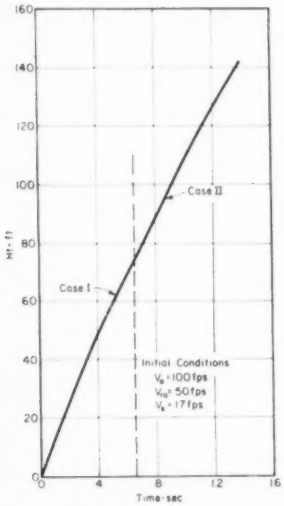

Fig. 2 Example of particle height increase with time

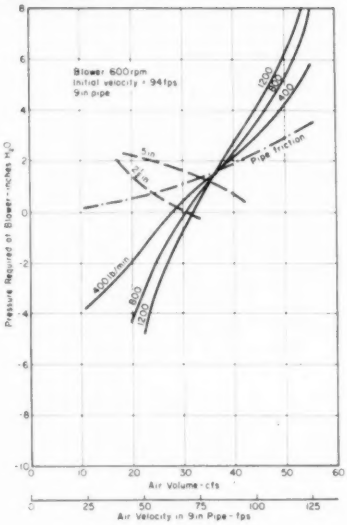

Fig. 3 Pressure-velocity relationships (blower at 600 rpm)

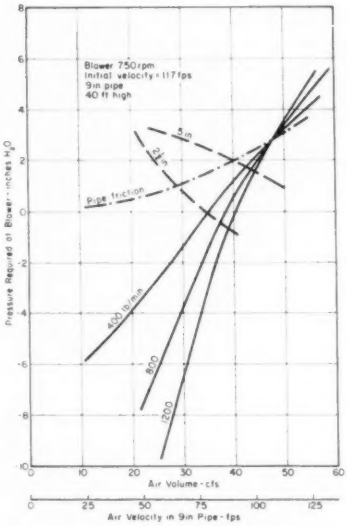

Fig. 4 Pressure-velocity relationships (blower at 750 rpm)

Example:

If the following conditions exist:

$V_a = 100$ fps

$V_{to} = 50$ fps (particle velocity 150 fps)

$V_s = 17$ fps (estimated from data on straw and grain by Persson [5])

Rate of feeding = 10 lb per sec = 600 lb per min

Pipe diameter = 9 in.

Pipe height = 41 ft

Equations [3] and [6] (Case 1 as plotted in Figs. 1 and 2) give:

$t = 0.33$ sec (from 0 to 41.35 ft)

$V_t = 9.2$ fps (at exit)

Particle velocity = 100 + 9.2 = 109.2 fps and

Total velocity change = 150 − 109.2 = 40.8 fps

The portion of this caused by gravity = 0.33 sec × 32.2 fps^2 = 10.6 fps

$\triangle V_f = 40.8 - 10.6 = 30.2$ fps

$$F = \frac{10 \text{ lb per sec of material}}{32.2 \text{ fps}^2} \times 30.2 \text{ fps} = 9.39 \text{ lb}$$

Pressure difference = 9.39 lb/(4.5 in.)^2 π = 0.151 psi = 4.2 in. H_2O.

Pipe friction may be computed as shown by Henderson and Perry (3) and will be equal to 2.35 in. H_2O.

The total pressure difference between the ends of the pipe will be 4.2 − 2.35 = 1.85 in. H_2O. Since the top of the pipe is open to the atmosphere, the pipe inlet will be at a

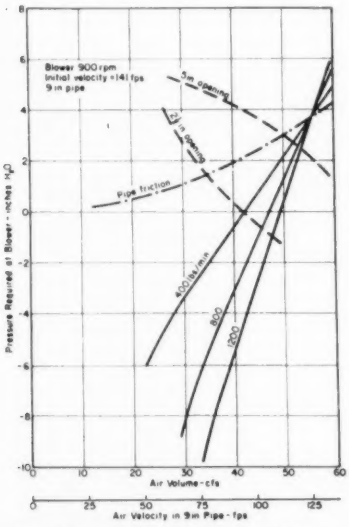

Fig. 5 Pressure-velocity relationships (blower at 900 rpm)

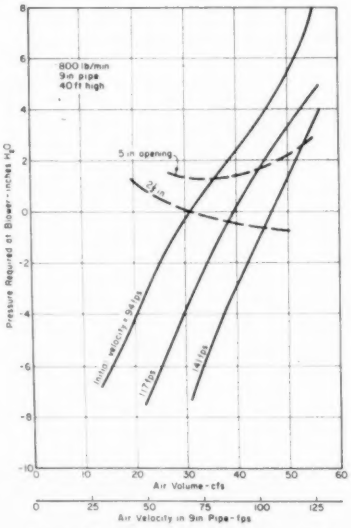

Fig. 6 Effects of various initial particle velocities on required air characteristics

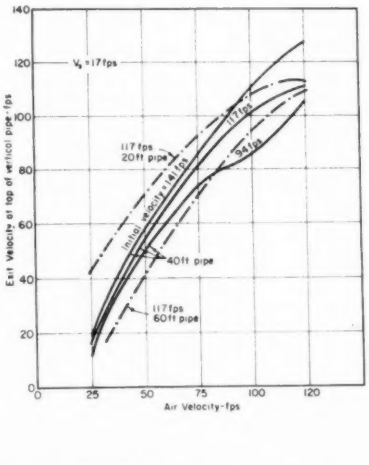

Fig. 7 Particle exit velocities in relation to air velocity

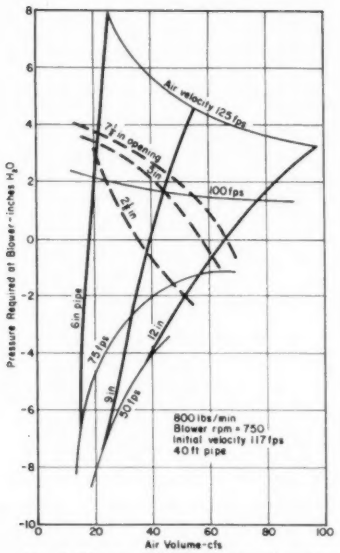

Fig. 8 Effects of fitting pipes of various diameters to a given blower

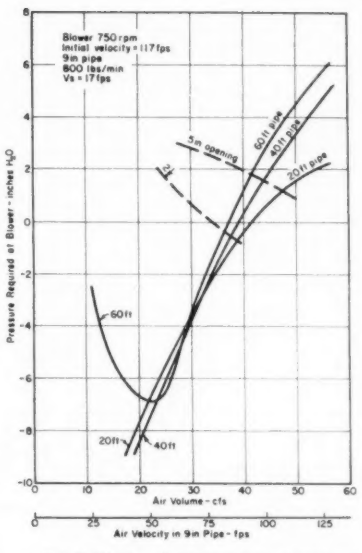

Fig. 9 Effects of fitting pipes of various lengths to a given blower

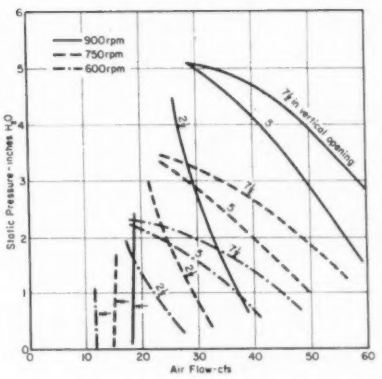

Fig. 10 Blower air-movement characteristics

pressure that is 1.85 in. H_2O less than that of the atmosphere. This phenomenon was also found experimentally by Duffee (2) and Smith (7) in operations under conditions similar to those given in the example.

The range of possible conditions in a vertical pipe can be illustrated by employing these analyses with assumed initial conditions within a commonly expected range. The solid lines in Figs. 3 through 9 represent values obtained using $V_s = 17$ fps with the computational procedure illustrated in the example. Figs. 3, 4, and 5 give pressure-velocity relationships for various rates of feeding at three initial particle velocities in a pipe 40 ft high. These velocities correspond to the tangential velocities of a 3-ft impeller at 600, 750, and 900 rpm. A companion scale shows the total air flow in a 9-in. pipe.

It can be noted that these curves intersect at a common point falling on the curve of pipe friction. This point represents the conditions at which the material adds as much energy to the airstream as it subtracts.

Fig. 6 compares the relationships at these three initial velocities for a material feeding rate of 800 lb per minute.

The exit velocities found in the computations for three initial particle velocities and three pipe lengths at one initial velocity are shown in Fig. 7.

It is possible to compare the results of fitting a given impeller blower with pipes of different diameter or length. Figs. 8 and 9 illustrate conditions when the initial particle velocity is 117 fps and the rate of feeding is 800 lb per minute. In Fig. 9 the rapid increase of pressure as air velocity for the 60-ft pipe drops from 50 fps shows what takes place when the material is truly blown up the pipe during the last portion of its traverse.

Figs. 3 through 9 illustrate the range of operating conditions in a vertical pipe. These conditions are presented relative to the air movement characteristics of the attached blower. Determining these characteristics permits establishment of a definite set of operating conditions.

Blower Air Movement Tests

An Allis-Chalmers forage blower was fitted with an adjustable restriction at the inlet. Attached was a 14-ft vertical section of 9¼-in. pipe with a pitot tube fixed in the center of the pipe at the top. On top of this was attached a 4-ft section of pipe and an adjustable restriction.

Inlet openings of ½, 2½, 5, and 7½ in. by 16 in. were used to simulate the inlet blockages caused by various rates of feeding. The blower was operated at 600, 750, and 900 rpm.

At each operating condition, static and velocity pressures were recorded as the outlet restriction was varied from fully open to fully closed. Velocity pressures were then interpreted to values of mean air velocity as shown by Henderson and Perry (3). Static pressures were corrected for pipe friction to give the value at the pipe inlet. Fig. 10 shows the results of some of these tests.

When some of these curves are superimposed on those of Figs. 3, 4, 5, 6, 8, and 9 (dashed lines), operating conditions may be ascertained by selecting a particular rate of feeding and the height of inlet opening associated with it. For the blower studied, 500 lb per minute of wilted chopped forage would be sufficient to fill the inlet opening completely when operation is at 750 rpm. However, the air flowing into the inlet tends to accelerate some of the forage entering the blower, and during high-capacity operation has been observed to maintain a 1 to 2-in. vertical opening 16 in. wide over the inflowing stream of forage. This indicates that, for rates of feeding of over 500 lb per minute, the conditions can be represented fairly closely by the 2½-in. opening characteristics.

Figs. 3, 4, and 5 show the following:

1 When material is passing through the blower at normal rates, the pressure at the blower outlet will most probably be in the range of +1 to −1 inches of water, with negative pressures both possible and probable.

2 As the rate of feeding is increased, the pressure at

(Continued on page 176)

Hay-in-a-Day Harvesting

Thomas T. Pedersen and Wesley F. Buchele
Assoc. Member ASAE *Member ASAE*

An introduction to this article entitled "Drying Rate of Alfalfa Hay" was carried in the February issue

THE all too common experience of hay farmers is to mow high-quality alfalfa and store, after weather damage, less than 60 to 70 percent of the total dry matter in the form of low-quality hay. One of the primary reasons for this loss lies in the fact that the period between rains during the haying season is less than the field drying time of the hay.

Using the best equipment available for the conventional method of hay harvesting—cutting the forage followed by crushing or crimping of the stems—a minimum of two days under good haying conditions is required to dry the conditioned hay to a storable moisture content of 20 percent in Michigan.

The possibility for harvesting high-quality, first-cutting hay is generally low due to frequent showers during the month of June. In July the possibility for two or more consecutive days without rainfall is considerably better, but overmatured hay has low feed value(2)*.

Rains reduce the quality of the hay by *(a)* leaching of the nutrients, *(b)* bleaching, and *(c)* increasing the number of mechanical treatments. Windrowing and raking shatters leaves, especially when these operations are carried out at moisture contents below 45 percent.

The leaves are the most valuable part of the hay crop. Approximately 70 percent of the total protein content and approximately 90 percent of the carotene content are contained in the leaves(4). With today's method of curing hay in the field, at least 20 percent of the leaves are lost. This figure is considerably larger when wetted by rains.

To cut these losses the method for handling hay in the field should be designed to fulfill two requirements: *(a)* save all the leaves even those dropped from the stem, and *(b)* promote rapid curing to reduce the possibilities of rain damage. This article is the second of two articles concerned with increasing the drying rate of hay (6).

When the hay is placed in the swath for curing, the water vapor evaporated from the soil escapes through the layer of hay and raises the relative humidity of the air in the hay. This causes a decrease in vapor-pressure differential between the hay and the surrounding air and tends to slow the drying rate of the hay. During parts of the night and day the hay may gain moisture from the high humidity air. In Michigan, the soil is often near field capacity when the first cutting of alfalfa is harvested.

Five individual hay-harvesting experiments were conducted and are presented in this paper in chronological order.

Effect of Soil Moisture Content on Drying Rate of Hay

A laboratory experiment was conducted by placing hay on boxes of soil containing two different moisture contents: 4.3 (air dry) and 15 percent. The depth of the soil in the bins was six inches.

Half the area of each box of soil was covered with transparent polyethylene impermeable to water vapor. Uncrushed and hard-crushed alfalfa were dried on these soils.

The curves in Fig. 1 represent the percentages of total water in the green plant evaporated at a given time. They indicate that there was little or no difference in the drying rates of hay when dried in the laboratory on air-dry soil, air-dry soil covered with plastic, or wet soil covered with transparent polyethylene. The air-dry soil under the hay increased the drying rate a small amount. The difference between these three treatments, however, was so small that it would not have any practical influence on the drying time. For this reason, the curve as drawn, is the average line of the three; the maximum deviation from this average curve did not exceed 2 percent.

The difference between these treatments and that of drying the hay directly on the soil containing 15 percent moisture was considerable. After 22 hours of drying, 80 percent of the total water was evaporated from the hard-crushed alfalfa placed on wet soil. The corresponding number was 94 percent for hay placed on dry soil or on polyethylene covered soil. For the uncrushed samples the difference was even greater, although not nearly as much water had been evaporated.

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Cornell University, Ithaca, N. Y., June, 1959, on a program arranged by the Power and Machinery Division. (This article is based on an M.S. thesis by T. T. Pedersen entitled, "The effect of conditioning and physical environment on the field drying of alfalfa," and is authorized for publication as Journal Article No. 2448 of the Michigan Agricultural Experiment Station.)

The authors — THOMAS T. PEDERSEN and WESLEY F. BUCHELE — are, respectively, assistant professor of agricultural engineering, Royal Veterinary and Agricultural College (Copenhagen, Denmark), and associate professor of agricultural engineering, Michigan State University.

Acknowledgment: The authors appreciate the financial assistance in support of this study by the National Academy of Science and the International Cooperation Administration.

*Numbers in parentheses refer to the appended references.

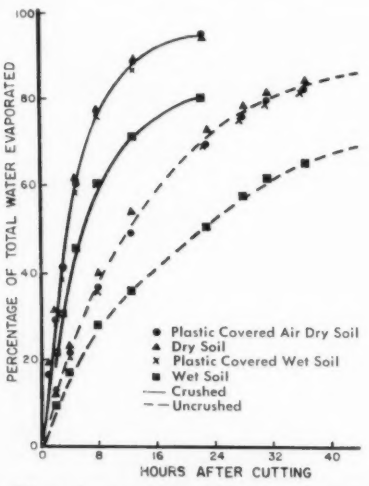

Fig. 1 Effect of vapor barrier on water evaporation from mechanically treated plants

Table 1 shows the moisture content (wet basis) of the different samples after 22½ hr of drying. This table indicates that covering the wet soil with an impermeable membrane influenced the drying rate to such an extent that the

TABLE 1. THE MOISTURE CONTENT (WET BASIS) IN THE DIFFERENT SAMPLES AFTER 22½ HOURS OF DRYING

Treatment	22½ hours of drying Moisture content in percent (wet basis)
Crushed + dry soil	14.1
Crushed + dry soil + polyethylene	16.7
Crushed + wet soil + polyethylene	15.7
Crushed + wet soil	40.3
Uncrushed + dry soil	50.6
Uncrushed + dry soil + polyethylene	52.5
Uncrushed + wet soil + polyethylene	52.4
Uncrushed + wet soil	63.7

hay dried to approximately 15 percent in 22½ hr when it was hard crushed, while the uncrushed hay dried to 52 percent. The corresponding figures for hay on the wet soil were 40.3 and 63.7 percent, respectively.

This experiment indicates that it was possible to reduce the drying time by eliminating the influence of a moist drying bed. When studying these data, it should be remembered that the experiment was conducted in the laboratory. The drying time in the field can be expected to be considerably shorter on account of the influence of solar radiation and greater air movement through the sample.

Field Drying in Plastic

In order to take advantage of the solar energy, the following experiment was conducted in the field. The alfalfa was cut at 8:30 a.m. and dried on black polyethylene, transparent polyethylene, and on the ground. Three degrees of crushing were applied—hard crushed (the stem surface nearly disintegrated), normal crushing (nearly equal to that of a commercial roller-type hay crusher), and uncrushed alfalfa.

Fig. 2 shows a portion of the drying curves obtained from the experiment. (The moisture content in percent [dry basis] is plotted versus drying time on semilog paper.) An analysis of the graph for hard-crushed alfalfa placed on black polyethylene shows that the drying rate was nearly constant to a moisture content of 25 percent (20 percent wet basis). In this case the drying of the hay was completed during the time of decreasing relative humidity in the air. Climatological data is presented in Table 2.

The number of hours required for the hay to reach a moisture content of 20 percent (wet basis) is tabulated in Table 3.

Neither of the treatments placed on the ground reached a storable moisture content within three days of drying. At 4:30 p.m. of the third day the crushed sample showed a moisture content of 21.6 percent (wet basis) that of the uncrushed 24.5 percent (wet basis).

TABLE 2. CLIMATOLOGICAL DATA

	Relative humidity Max.	Min.	Air temperature Max.	Min.
	Percent		Deg. F	
First day	56	39	79	77
Second day	63	52	74	80
Third day	61	47	83	73

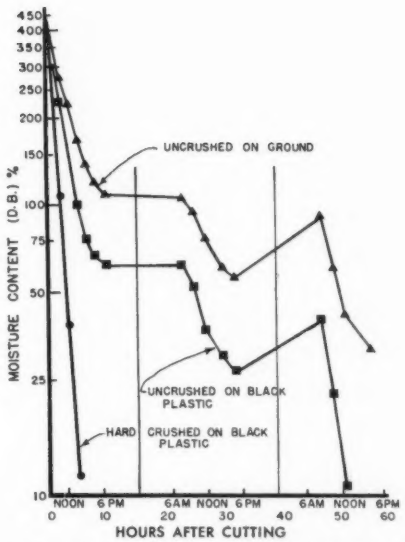

Fig. 2 The effect of vapor barriers on field-drying rates

During this experiment the surface temperature of the polyethylene, the hay sample and the air were recorded. The relative humidity of the air was determined 6 in. above the ground.

During the first day of the experiment, when the sun was shining, the energy received by the polyethylene by radiation raised the surface temperature of the black plastic an average of 40.3 F and that of the transparent plastic 21.2 F.

Even on the second day (partly cloudy or overcast during the main part of the day) the increase in temperature was 24.2 and 16.4 F for black and transparent polyethylene, respectively.

The radiation energy increased the temperature of the air in the hay. The temperature rise was highest for hay on black plastic, less for transparent plastic, and lowest for hay on the ground.

Averages cannot be made here because the rise in temperature depends on the amount of evaporation from the sample. When the evaporation from the sample was high, as it was in the case of hard-crushed alfalfa on black and transparent polyethylene during the first two hours of drying, the increase in the sample temperature was relatively small. In this case most of the absorbed energy was apparently used for evaporation of water from the sample. As soon as the rate of water evaporation decreased, the sample temperature increased.

TABLE 3. REQUIRED TIME FOR THE DIFFERENT TREATMENTS TO REACH A MOISTURE CONTENT OF 20 PERCENT (WET BASIS)

Treatment	Time, hours after cutting
Hard-crushed alfalfa on black polyethylene	4.0
Hard-crushed alfalfa on transparent polyethylene	6.5
Crushed alfalfa on black polyethylene	25.5
Crushed alfalfa on transparent polyethylene	28.5
Uncrushed alfalfa on black polyethylene	49.5
Uncrushed alfalfa on transparent polyethylene	51.5
Crushed alfalfa on ground	>56
Uncrushed alfalfa on ground	>56

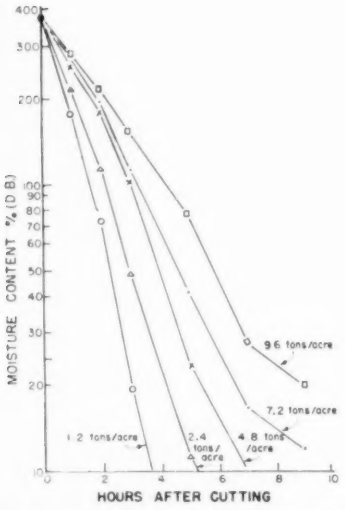

Fig. 3 Drying curves for alfalfa when different initial amounts per square foot are placed on black polyethylene

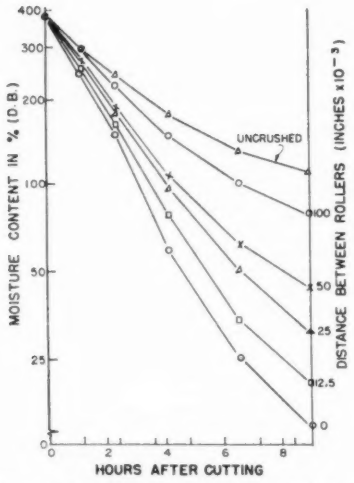

Fig. 4 Drying curves for alfalfa crushed at different degrees

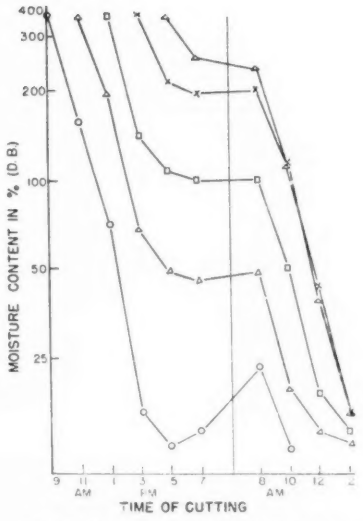

Fig. 5 Drying curves for alfalfa cut at various times of the day

. . . Hay-in-a-Day

Thickness of Hay Layer on Plastic

The thickness of the layer of alfalfa placed on the polyethylene will obviously affect the drying time. The maximum amount of hay that could be placed per square foot of polyethylene and still be able to reach a moisture content of 20 percent within the same day as the hay was cut was determined experimentally.

The results of this research are shown in Fig. 3. These graphs indicate that all the samples reached a storable moisture content the same day as the hay was cut. The time required for the different amounts of hay to dry to 20 percent (wet basis) is shown in Table 4.

Even with an amount of hay equal to 7.2 tons of 20 percent hay per acre, it was possible on a good drying day to store hay 6 hr after cutting. These results indicate that it would not be necessary to cover the whole field with polyethylene to dry the hay. A swath could be placed on a strip of polyethylene one-third to one-half the width of the mower cutter-bar, depending on the yield of alfalfa.

Degree of Crushing

The crushing unit used in these experiments was fabricated by Butler(1) and consisted of two cylindrical rollers with smooth surfaces. Contrary to the conventional hay crushers, where the rollers are spring-loaded, this model was constructed in such a way that the clearance between the rollers is variable and can be fixed at any chosen clearance.

TABLE 4. TIME REQUIRED FOR DIFFERENT AMOUNTS OF HAY PER SQUARE FOOT TO REACH 20 PERCENT MOISTURE CONTENT

Yield, tons per acre (Hay with 20 percent moisture content	Time, hr
1.2	2.8
2.4	3.9
4.8	5.0
7.2	6.1
9.6	7.7

The degree of crushing influences the drying time. In order to determine the degree of crushing needed to field dry alfalfa to storable moisture contents the same day as it is cut, an experiment with the following clearances between the rollers was conducted: Less than 0.005 in., 0.0125 in., 0.0250 in., 0.0500 in., 0.1000 in., and check (uncrushed sample).

Fig. 4 indicates the results of this experiment. Only with a clearance of less than approximately 0.015 in. between the rollers was it possible to dry the hay to a moisture content of 20 percent (wet basis) within the same day as the hay was cut. This moisture level was reached after 6.5 hr of drying the hardest crushed sample, and after 8 hr for the sample crushed with 0.0125 in. clearance between the rollers. During most of the day on which this experiment was conducted, the weather was partly cloudy to cloudy. This explains the relative low drying rates. Black polyethylene was used as vapor barrier in this experiment.

Effect of Time of Cutting on Drying Rate

The drying curves of alfalfa cut at various times of the day were determined. An amount of hay equal to 3.6 tons of 20 percent hay was used in the experiment. A hard crushing was applied to the alfalfa. The hay was dried on black polyethylene.

The results are shown in Fig. 5. They indicated that only the sample cut at 9:00 a.m. reached a moisture content of 20 percent (wet basis) during the cutting day. By interpolating between the cutting at 9:00 a.m. and the cutting at 11:00 a.m., it is apparent that hay cut at 10:00 a.m. would reach a moisture content of 20 percent in approximately 8 hr of drying, or by 5:00 p.m. Climatological data are presented in Table 5.

TABLE 5. CLIMATOLOGICAL DATA

	Relative humidity		Air temperature	
	Max.	Min.	Max.	Min.
	Percent		Deg. F	
First day	72	49	75	66
Second day	74	50	75	65

All the samples, except the 5:00 p.m. cutting, picked up moisture during the night. The drier the sample, the greater the quantity of moisture absorbed during the night. This would be expected because the vapor pressure differential between the air and the hay sample is largest in the case of a dry sample.

Summary and Conclusions

Hay is the most important forage crop in the United States. Because field curing subjects hay to weather damage and as a result causes considerable loss of nutrients, it is important to find the best possible method of curing it.

By inserting a vapor barrier between the soil and the drying hay, the effect of evaporation from a wet soil was eliminated, and the time necessary to dry the hay to storable conditions was reduced.

When black polyethylene was used as a vapor barrier, it also absorbed radiation energy. The surface temperature was raised 40.3 deg above that of the surrounding air.

The results of this study indicated that hay mowed before 10:00 a.m., crushed (clearance between rollers less than 0.015 in.) and placed on black polyethylene sheets, will dry to a storable moisture content of 20 percent before 4:00 p.m., and may be harvested the same day as cut.

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FARMSTEAD ENGINEERING CONFERENCE IN SEPTEMBER

THE American Society of Agricultural Engineers, Farm Structures Division, in cooperation with the Agricultural Engineering Research Division, ARS, USDA, and Departments of Agricultural Engineering and University Extension, University of Illinois, will sponsor a Farmstead Engineering Conference on confinement housing of livestock at University of Illinois, Urbana, Sept. 13-15, 1960.

The special conference is the second of its kind sponsored by the Society, since it sponsored the Farm Materials Handling Conference in September, 1958.

The purpose of the farmstead engineering conference is to collect and disseminate the most current information on all factors affecting confinement housing of livestock and to summarize and bring into focus basic and functional design requirements relating to engineered farmstead and housing systems. Its objectives are: (a) To present the most advanced information from the standpoint of management, breeding, feeding, sanitation, marketing, and other future considerations which may affect farmstead engineering; (b) to present basic and functional requirements of animals in a way that is useful to designers; (c) to present design procedures and solutions for combinations of components for economical operation; (d) to point up areas in which basic research is needed; (e) to focus attention on cost vs. returns of engineering housing systems; (f) to focus attention on power requirements of engineered farmsteads; and (g) to publish this material in a special issue of the Journal for easy reference.

One-half day sessions will be devoted to each of the following: Poultry, swine, dairy, and beef. One evening session will be devoted to cost vs. returns from engineered farmsteads, and meeting capital requirements for engineered farmsteads. The second evening will consist of a dinner meeting in which future farmstead power requirements, and from where will the power come, will be discussed. On the afternoon of the third day, a tour of research installations is being planned.

The opening session will be held on Tuesday afternoon, September 13, and will be devoted to a Poultry program. T. C. Byerly, deputy administrator, Agricultural Research Service, USDA, will give the keynote address, and discussions on the functional and basic requirements of poultry housing, by A. D. Longhouse and M. L. Esmay, will follow. Combination of components for economical operation for poultry will be discussed by F. P. Stephan, L. N. Drury, and Denver O. Baxter. A Tuesday evening session will cover the topics of cost versus returns from engineered farmsteads, by Roy N. Van Arsdall and Velmar Davis, USDA agricultural economists; and meeting capital requirements for engineered farmsteads, by Douglas F. Graves, assistant vice-president of Chicago National Bank.

O. Burr Ross, head, animal science department, University of Illinois, will give the keynote address at the Wednesday morning program, which will be devoted to swine. The program will consist of talks by T. E. Hazen on the functional and basic requirements of swine housing; and combination of components for economical operation, by D. G. Jedele. The session on Wednesday afternoon, at which Woodrow Snyder, department of dairy, Michigan State University, will deliver the keynote address, will be a Dairy Program. R. E. Stewart and S. A. Witzel will discuss the functional and basic requirements of dairy housing, and the combination of components for economical operation will be covered by J. T. Clayton and Thayer Cleaver. The Wednesday sessions will be concluded with a 6:00 p.m. dinner meeting at which Herbert N. Stapleton, agricultural engineer, Shelburne Farms, will speak on the future farmstead power requirements, and Virgil Herriott, general manager, Sioux Valley Empire Electric Assn., Inc., will speak on "From Where Will the Power Come?"

A Beef Program is scheduled for Thursday morning, when C. F. Kelly and A. H. Schulz will discuss the functional and basic requirements of beef housing. The subjects of combination of components for economical operation, by N. H. Curry, and let's dream – the farmstead of the future, by H. J. Barre, will also be included on this program. A tour of research installations on Thursday afternoon will conclude the three-day conference.

The September issue of AGRICULTURAL ENGINEERING will be devoted entirely to farmstead engineering and by reason of the scope of the material it will contain, including all papers presented at the Conference, promises to be a comprehensive handbook on the subject, suitable for the engineer, manufacturer, dealer, and farmer alike.

. . . Relations of Air and Solid Particles

(Continued from page 171)

the blower outlet decreases and the air velocity in the pipe increases.

3 Increased blockage of the inlet area reduces both the pressure at the blower outlet and the air velocity in the pipe.

Fig. 7 indicates that the exit velocity of material at the top of the pipe is strongly dependent on the air velocity in the pipe, and that the exit velocity may be determined once initial particle velocity and air velocity are known.

The effects of pipe length are described by Figs. 7 and 9. In the normal operating range the longer pipe requires more pressure at the blower outlet and results in a lower equilibrium air velocity. The reduced air velocity combined with reduced exit velocity for any given air velocity, results in two-fold reduction in exit velocity caused by increased pipe length.

Fig. 6 shows that, for the conditions assumed and a feeding rate of 800 lb per minute at all times, the pressure of the blower outlet will drop gradually as the rotational speed of the blower is increased. Examination of similar figures prepared for various rates of feed indicate that, at 1200 lb per minute, the pressure drop will be more pronounced as speed increases, but that, at 400 lb per minute, pressure will remain essentially constant as speed changes.

Fig. 8 illustrates that, if the blower is operated at the conditions indicated with a large unblocked inlet area, little would be gained in airstream velocity if the pipe size were reduced from 9 in. to 6 in. However, with a 2½ x 16-in. unblocked opening, air velocity would be increased by using a 6-in. pipe. In all cases, increasing pipe size from 9 to 12 in. would result in a lower air velocity. Fig. 8 also indicates that a smaller pipe would result in higher pressures at the blower outlet. The operating conditions indicated in Figs. 3, 4, 5, 6, 8, and 9 closely correspond to measurement made by Barrington *et al* (1) and Smith (7). Fig. 11 shows the experimental points and plots (solid lines) recorded by Smith. Also plotted in Fig. 11 (dashed lines) are values predicted by the foregoing analyses and adjusted for a pressure tap height of 6 ft. The predicted and measured values are remarkably similar in both magnitude and characteristic.

Conclusions

Figs. 3, 4, and 5 show that under most conditions the pressure at the blower outlet is less than that required to overcome pipe friction. This indicates that the solid material is imparting energy to the airstream, rather than the reverse, as is implied by the term "blower"; and consequently the solids are slowed down. These figures also show that this condition could be improved by providing more air inlet area for the blower.

Figs. 3, 4, and 5 also illustrate how these analyses may be used to determine both the pressure and flow of air from the blower while solid material is being elevated. This permits evaluation of a term for air-energy output for further refinement of the energy balance for this machine.

Fig. 7 illustrates the dominant influence of air velocity on the particle-exit velocity from the pipe, and indicates that the primary function of air movement in the pipe is to reduce the effect of air resistance on the solid material. This influence can be illustrated by using equation [6] to show that when V_s=17 fps, material impelled upward into still air at 117 fps will rise only 15 ft.

Fig. 11 shows that these analyses are sufficiently complete to explain measured physical conditions.

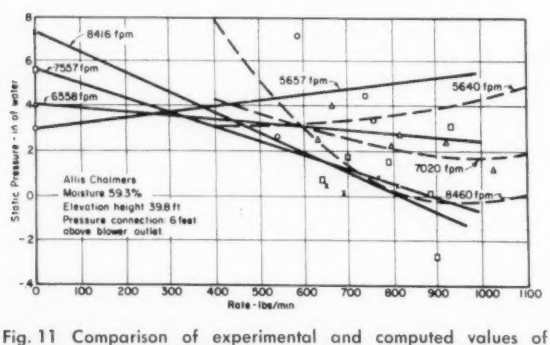

Fig. 11 Comparison of experimental and computed values of static pressure in the pipe. Solid lines and experimental points from Smith (7); broken lines computed

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Engineering Supply and Demand

FOLLOWING are estimates on engineering degrees awarded in 1959, as reported in a recent Engineering and Scientific Manpower Newsletter. During the year engineering colleges awarded 38,162 B.S., 6,761 M.S., and 713 Ph.D. degrees. The total of 45,636 represents the highest number of degrees since 1951, and an increase of 9 percent over 1958.

These represent increases over 1958 of 10 percent at the B.S. level; 16 percent for M.S. and 10 percent for Ph.D. The graduate degree trends are encouraging, particularly in view of the drop from earlier estimates of Bachelor degrees, due to increased drop-outs.

In the meanwhile, however, the engineering enrollment trend is definitely downward. In 1958, the freshman class dropped 11 percent over the previous year and a further decline occurred this year. The projection for degrees in the early 1960's has, therefore, been adjusted downward materially from earlier estimates.

This comes at a time when demand for engineers is again increasing. Results from the 1959 Engineering Manpower Commission Demand for Engineers survey — just completed — indicates that industry anticipates recruiting an increasing number of engineering graduates in the 1960's — when the current freshman class would graduate.

The Demand Report is available on request from the Engineering Manpower Commission, 29 West 39th St., New York 18, N. Y.

. . . Changes in Education

(Continued from page 153)

be found in the study of history, philosophy, sociology, comparative religion and literature.

One significance observed in the history of the development of progressive education is that the evolutionary change stimulated by Dewey did not reach its peak until forty years after its initiation. During that period of two generations the techniques projected by Dewey became half obsolete, yet they are now the nearly universal procedures of public school teachers trained through our colleges of education. America's public school system, commonly termed "progressive education," has not developed the flexibility to adjust itself to changing conditions even though it presumably came into existence as a response to a need for a change in traditional methods of education. If the next major change in educational procedures requires another forty years, our schools in the year 2000 will be preparing students to fit the needs of 1960 by using the techniques applicable to the scientific and social world of today. By some means we must accelerate educational change, or we may not exist through another forty years as a democratic society.

Engineering Education

The situation in engineering education until the last twenty years was not unlike that in the field of professional education. Engineering had developed to the stage of applying the early scientific method of crude experimentation to the rough solution of a variety of practical problems. We loaded large structures to determine their elastic limits; we measured the flow through an orifice or weir and established an empirical formula to express rate of flow; we measured electrical or thermal potential and related our measurements to other experimental observations without much use of conceptual relationships or scientific theories.

It took an influx of European theoreticians to change our values by demonstrating the practical usefulness of theory in solving engineering problems. Karapetoff before and after World War I provided an early influence upon electrical engineering which may explain why curricula in electrical engineering commonly included differential equations twenty years ahead of other engineering curricula. Timoshenko some fifteen years later forced American engineers to re-evaluate the importance of theory in the field of engineering mechanics and its applications. Bakhmeteff accomplished the same result for the field of fluid flow. Ipatieff produced a revolution in the petroleum refining field, while Von Karman led the aeronautical industry into the use of theory and of experiment guided by mathematical concepts. Perhaps it will now seem significant that four of the five early leaders of engineering science in America were ex-Russians. Russia like other European countries has always placed great emphasis in engineering education upon mathematics and basic science as background for the engineering sciences of solid and fluid mechanics, thermodynamics, mass and heat transfer, electrical circuits and fields, and the study of engineering materials. It appears that her engineers have not suffered in their practical ability, since photographing the far side of the moon requires more use of engineering know-how than application of pure science.

The demonstrations of the importance of theory in the areas of engineering science as a new tool of engineering practice, mentioned above, occurred between the two world wars. The shortage of engineers with adequate training in science was demonstrated during the decade 1945-1955 by the emphatic use in the AEC of physicists for the most responsible positions, even in administration. In 1950, aeronautical manufacturers were selectively hiring engineers but were grabbing any available physicist and classifying him immediately as an engineer. Even today, the aeronautical and electronic industries classify their scientific personnel as engineers and direct their interests toward solving practical problems. Industry has simply found that it can more easily make an engineer of a scientist than it can produce an adequate understanding of mathematics, physics or chemistry in an engineer trained to apply art rather than science to engineering situations.

How long will it take engineering education to accept the verdict of industry and then readjust curricula to provide a scientific and also a humanistic background for engineers? It is my opinion that we have closed about 10 percent or at most 15 percent of the gap in five years, so perhaps forty years will accomplish the job. Except, of course, that science and civilization will also have progressed and widened the gap that we are trying to narrow by an asymptotic approach. Again, as in the field of public education, perhaps we cannot afford a forty-year period of adjustment.

We must find a way to make engineering education more responsive to changes in the science that it is intended to apply. I think the solution is self-evident but not easy to achieve. Despite the composition of industry we must employ as teachers a larger percentage rather than, as has been predicted, a smaller percentage of scientifically oriented engineers. In the last few years more than one-half of new engineering PhDs have gone into industry to meet in part its voracious appetite for those who can contribute to making new applications of science. We could use every single PhD graduated in the next ten years as a teacher even though we triple the production of our graduate schools. Can anyone imagine the Soviets permitting their industrial managers to offer large enough salary inducements to strip their universities of creative engineering talent? Since we cannot reduce industrial offers, our system must and shall be to match such offers in our universities. We already pay professors of surgery, psychiatry and internal medicine $25,000 salaries. We will certainly make some appointments at this level in engineering education before long. We will do so because the alternative is to fail to hold our position as the number one or perhaps even the number two industrial nation.

When our engineering faculties are properly weighted with teachers who have no fear of advanced mathematics and no inhibitions about making use of the most recent advances in science, where applicable to engineering situations, curricula will change much more rapidly than they have in the past. The argument is fallacious that only a few engineering students can handle advanced mathematics and modern physics. Young men are neither brighter nor less bright in this country than in Europe. Objective tests for admission to the graduate school of the University of Florida prove that the intelligence level of engineering applicants is higher than that for any field of science or mathematics, except for a slight edge of the applicants in physics. Engineering students can pass any course given by any department in the university if they are first given the necessary prerequisite background. However, for motivation, they should be told that the engineering faculty considers the course that they are studying to be important to their success as engineers whether it be English, mathematics, physics or economics.

In order to make room for a larger proportion of fundamental science, engineering science, and humanities in engineering curricula, something must be reduced or omitted. An important test of each bit of material in an engineering curriculum is the breadth of its usefulness or its transferability from one situation to another. English and mathematics are used in essentially every advanced course and by nearly all engineers in practice, so these courses may be classified as fully transferable. Some courses, and particularly parts of courses, are so specialized toward the art of engineering practice that they can be used only by one who specializes after graduation in a narrow field of engineering. Elsewhere I have analyzed the mathematical probability that a given student in civil engineering will use specialized art of highway, sanitary or structural practice and have shown that only one or two students in a class of twenty can be expected to make use of such specialized knowledge which also has a surprisingly high factor of obsolescence. When such material is partly removed from engineering curricula, one finds that the crowding is much relieved. Hence, the need for five years of study for the bachelor's degree is not so clear as the need for intensive housecleaning of our current four-year curricula.

The coming problems of engineering educators include the handling of greatly increased numbers of undergraduate students without adequate numbers of qualified teachers. To bring these diverging streams together will require that engineering education give up some of its affection for early specialization with the teaching of more common subjects in large sections. Since during the post-war bulge I taught classes in engineering mechanics as large as 300 students, I can certify that there need be no loss of teaching efficiency when the lecturer is provided with the necessary assistants to serve as tutors for answering questions and for aiding students in problem solutions. In time, of course, the swelling numbers of graduates will build up the graduate schools and increase the numbers of available teachers. In the interim period, colleges of engineering may be forced to employ mathematicians to teach mechanics, chemists to teach in chemical engineering, and physicists if available to teach electrical and aeronautical engineering. There would be a lasting beneficial effect on engineering education from

this marriage of mathematics, science and engineering. As a matter of fact, the employment of science teachers by engineering departments has been noticeably increasing.

In summary, the great weakness of engineering education is that it has not clearly recognized the duality of its responsibility to society, first to train engineers to solve the usual day-by-day problems of a technological world, but, secondly, to educate real applied scientists who will create new technologies. We cannot continue to depend upon about one percent of engineers, mainly PhDs to serve as translators of scientific and mathematical research into engineering advances. It is necessary for engineering education to face up to its responsibility to educate at least twenty-five percent of undergraduate engineers for service as engineering or applied scientists.

Agricultural Education

The problems of agricultural education are in some respects similar and in other respects different from those of engineering education. The basic similarity is that engineering and agriculture are both fields of applied science. Engineering mainly applies to physical sciences and mathematics while agriculture makes use of all biological sciences, chemistry and mathematics. In contrast to engineering, agricultural research has made effective use of workers from the fields of science, i.e., botanists, bacteriologists, biochemists, statisticians, etc. Also, as in engineering, research and teaching unfortunately have been separated in some areas of agriculture. The result has been to leave some teaching departments unstimulated by research with the unprogressive results that could be predicted. Accordingly, such departments in agriculture have been unable to carry out the dictum that a teacher must be engaged in research to continue stimulating his students over his entire lifetime, and, possibly more than engineering, have retained their teaching of art, techniques and professional practice with lack of sufficient emphasis upon mathematics, pure science and applied science.

The result of this failure to base courses in agriculture directly upon advances in science rather than the art of the field has had an unfavorable effect both upon the numbers of students registered in the colleges of agriculture and upon the intellectual capacities of these registrants. Students are fully aware of the advances of modern science and its successful applications in medicine, engineering and agriculture. They are obviously engaged in boycotting these areas of scientific education that are still primarily teaching the methods of shotgun experimentation and rule-of-thumb practice. Instead, they seek curricula emphasizing applications of theory and modern scientific experiment to practical problems. There is a great difference between these educational concepts. Students readily sense this difference.

In order to maintain its classes, an unprogressive department can only lower its admission standards and raise the level of its grades. This attitude has progressed so far in a few areas of agriculture that sound educational procedures can hardly be reestablished without rather drastic changes. One can readily observe the strains involved as such changes are being contemplated in some places and actually initiated at others. If colleges of agriculture will accept their new role of producing applied scientists for agriculturally based industry and other agricultural agencies, they will draw increased numbers of students and will compete on a favorable basis for the best students with engineering, medicine and the other professions.

A requirement for many areas of agriculture, that has been neglected unreasonably, is curriculum adjustment to increase the student's preparation in mathematics. Years ago, when engineering curricula required no more than calculus, it may have been reasonable for agricultural students to terminate mathematics with the study of algebra. Today, however, when engineers are required to study advanced mathematics, calculus could realistically be added to most curricula in agriculture. Then, as graduate students, the agricultural scientists would be prepared to study mathematical statistics as a background for the scientific planning of experiments, sampling procedures, and analysis of data obtained from a wide variety of sources. Machine programming would be more widely used and understood. Those who should study physics would be prepared to do so. Without a reasonable mathematics background today, an applied scientist in any field finds himself cut off from a major fraction of the scientific literature. The fact that agriculture has a heavy dependence upon systemic biology and botany has tended to mask its equal dependence upon chemistry, radiation botany and biology, nuclear physics and statistical science, all of which are largely closed to the individual without basic mathematical preparation. An important change would come about in agricultural education, both directly and indirectly, from the requirement that two years of standard mathematics should be included at the undergraduate level.

Agricultural Engineering Education

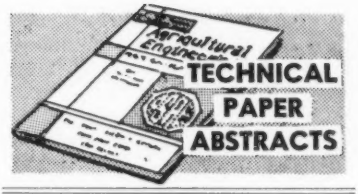
I am not sufficiently well acquainted with curricular details and teaching methods in agricultural engineering to serve as a critic. Perhaps my understanding, however, of education in general, and engineering education in particular, may provide some helpful suggestions. Hence I would like to commend to teachers of agricultural engineering the strong practices from both engineering education and agricultural education while avoiding their obvious weaknesses.

Agricultural engineering should therefore follow the usual practice in engineering of integrating education and research in one faculty housed in a single location. Only in this manner can the stimulating influence of research be brought to bear upon each faculty member. The department should adopt the philosophy that research is essential to good teaching and make use of modern channels for industrial and governmental sponsorship of research. If research is slow to develop, it can be stimulated by employment of one or more scientists or research engineers from another discipline. Cross-fertilization is an effective technique. This technique is one of the most successful from the personnel experience of the agricultural experiment stations, and it could be a stimulating factor in any department of engineering.

Agricultural-engineering education should equal or exceed the standards of other engineering disciplines in regard to their minimum requirements of mathematics and the physical sciences. In the life sciences the agricultural engineer is obviously controlled by the prerequisities set by the college of agriculture for admission to whatever courses in agriculture he may elect or be required to take. Since agricultural engineers are by necessity more diversified in their engineering activities than electrical, chemical or mechanical engineers, they should depend more heavily than other engineers upon a strong background in engineering science with less emphasis upon specialized design courses or courses in specialized practice. Although I do not suggest that the following is the common objective, I wish to emphasize that one cannot learn in four years of college how to lay out a dam, an irrigation system, a building and an electrical distribution system, along with attention to economics, management principles and the several other important objectives that occur to each person according to his experience. We should not plan a curriculum having in mind objectives which are too widespread. The concept of a strong background in the engineering sciences with limited and concentrated experience in analysis and design, in a single field of interest to the student, probably represents the strongest achievable undergraduate engineering preparation for agricultural engineers. This background is highly transferable to any engineering work that may be involved in later practice. Inclusion of many unrelated practical engineering courses in the undergraduate curriculum would result in a low transferability of knowledge. Also, these unrelated courses must necessarily be taught at such an elementary level as to be of little actual value in practice. As to humanistic studies, it is worth considering that agricultural engineers may have even greater need than more specialized engineers for use of written and spoken language along with an understanding of human nature.

The agricultural engineering department should be able to demonstrate to the college of agriculture that high admission standards and stiff grading do not reduce enrollments over the long term. These procedures merely attract stronger students. Then it should be able to demonstrate to the college of engineering that a curriculum based on engineering science rather than specialized engineering practice will appeal to many of the best students. But no department will be able to accomplish these things unless its faculty carries to its students the stimulation engendered by its own research. If agricultural engineering education has been as slow in adopting the advances of physical science, mathematics, and biological science as has its engineering and agricultural associates, it has a major problem of evolution to face. The key to this change is a strengthening of faculties by adding those who set a high value upon scientific, agricultural, and engineering research.

Following are brief reviews of papers presented at ASAE meetings or other agricultural engineering papers of which complete copies are available. ASAE members may obtain copies of these papers without charge by returning order forms supplied upon payment of membership dues. Nonmembers, and members requesting more than 10 copies, may purchase papers at 50 cents each to cover carrying charges from the American Society of Agricultural Engineers, St. Joseph, Mich.



A Successful Hog Finishing Facility—The Feed Handling System, by Marshall F. Finner, assistant professor of agricultural engineering, University of Wisconsin, Madison. Paper presented at the Winter Meeting of ASAE, at Chicago, Ill., December 1959, on a program arranged by the Farm Structures Division. Paper No. **59-802.**

This paper describes a feed handling system developed for limit-feeding of large numbers of hogs in a hog finishing house. The system was designed to automatically weigh out predetermined amounts of feed for each pen of hogs in the house, convey the feed to the pens, and distribute it in the feeders—all by merely turning a knob on a control panel. Augers are used for conveying and distributing the feed throughout the system. An electrically operated weigher weighs out feed in 25 lb amounts. A switch on the weigher sends an impulse to the control panel for each dump of feed weighed. The impulse of current actuates a magnetic counter and a stepping switch is so connected as to stop the weighing of feed for any one pen when the present number of dumps have been weighed. The paper goes on to describe in detail the various components of the system, including the control circuit.

An Electrical Resistance Method of Measuring Cotton Fiber-Length Distribution, by A. W. Hartstack, agricultural engineer, AMS, USDA, Washington, Texas. Paper presented at the Winter Meeting of the ASAE, at Chicago, Ill., December 1959, on a program arranged by the Electric Power and Processing Division. Paper No. **59-908.**

Length is recognized as one of the important physical properties of cotton fibers. A fast and accurate method of determining the length distribution of a cotton sample has been the ultimate objective of cotton instrumentation researchers for a number of years. This paper presents a method for determining the length and length distribution of a cotton sample by measuring the electrical resistance of the fibers at $\frac{1}{8}$-in. intervals along their length. The electrical properties of cotton can be measured successfully provided the relative humidity and temperature are held constant. A standard commercial drawing frame proved satisfactory as a laboratory device for rendering the cotton fibers parallel. The parallel fibers are then clamped in a vise and the loose fibers combed out. The vise with a sample is placed in a holder and a metal comb is mechanically drawn through the fibers. The electrical conduction is measured and recorded by a graphic recorder as the comb is drawn through the fibers. The length distribution can then be computed from values obtained from the recorded curve. Data obtained from a number of samples presented to the resistance device are also included. The results obtained with the resistance device are compared to results obtained when using the Suter-Webb sorter and to results obtained when using the Fibrograph. Good agreement is shown between the resistance measurements and the Suter-Webb array determinations. The average of four replications are used for each resistance determination. Ten to 15 minutes are required for the sample preparation and measurement of four samples.

Gully Control Without Structures, by Warren S. Harris and Ralph C. Hay, respectively assistant professor, agricultural engineering dept., University of Arkansas, Fayetteville, and coordinator of ICA programs and professor of agricultural engineering, University of Illinois, Urbana. Paper presented at the Winter Meeting of ASAE, at Chicago, Ill., December 1959, on a program arranged by the Soil and Water Division. Paper No. **59-701.**

Many gullies can be reclaimed without structures by using shaped outlet sections, with vegetation, to serve the purpose of structures. This paper discusses the design of these outlets which should be based on a knowledge of the contributing causes of gully development. In the particular area considered in the paper there are two major factors that contribute to gully erosion and two minor factors. The major factors are: (1) Aggradation in waterways resulting in the creation of unstable situations; and (2) uncontrolled base flow from improperly constructed tile drains. The minor factors are: (1) the destruction of vegetal cover; and (2) livestock activity. Design of outlet sections is based on the assumption that measures taken to control one factor will complement measures taken to control other factors. Five case studies of field installations are reviewed with the following two conclusions: (1) Erosion control structures are alternate solutions rather than only solutions to waterway termination problems in gully control; and (2) benefits from structures often are limited to small areas of non-productive land. A series of three design curves are presented to aid in the design of "transition sections" for terminating waterways for gully control. It is pointed out that these curves may prove valuable for grass waterway design.

Improved Procedures for Grass Waterway Design, by Curtis L. Larson and Deane M. Manbeck, associate professor and research assistant, agricultural engineering dept., University of Minnesota, St. Paul. Paper presented at the Winter Meeting of ASAE at Chicago, Ill., December 1959, on a program arranged by the Soil and Water Division. Paper No. **59-700.**

Previous work at the USDA Outdoor Hydraulic Laboratory in Oklahoma showed that the Manning coefficient "n" for grass waterways is not a constant, but a variable.

In this paper, simplified procedures for applying the Oklahoma data on retardance of grasses are presented. Approximations for the hydraulic radius are developed for triangular and parabolic channels, and shown to be within one percent of true values except for very narrow waterways. These approximations enable one to make a direct solution for the required depth and width of a triangular or a parabolic grass waterway.

For trapezoidal waterways having 4 to 1 sideslopes, a single chart was developed to relate the four principal elements of the cross-section: Depth, bottom width, area and hydraulic radius. Knowing any two of these, one can readily determine the remaining elements. Used in conjunction with the previous data on retardance of various grasses, trapezoidal waterways can also be designed quickly and accurately. A new method for determining freeboard for grass waterways is developed.

Lighting Fruit Packing Areas, by Marvin E. Heft, Jr. and Dennis E. Wiant, respectively, farm service advisor, Consumers Power Co. (formerly graduate assistant, Michigan State University, East Lansing), and professor, agricultural engineering, Michigan State University, East Lansing. Paper presented at the Winter Meeting of ASAE at Chicago, Ill., December 1959, on a program arranged by the Electric Power and Processing Division. Paper No. **59-904.**

Lighting of the fruit grading operation requires a light source that is of the proper quality and quantity if the worker is to be able to detect the defective fruit with a minimum of time and effort and with maximum accuracy. This paper deals with this lighting problem and it is pointed out that the proper quality light source can be determined by one of two means—theoretical or observational. The theoretical method involves the determination of the coefficient of correlation of a two variable correlation between the visibility function curve of the various light sources and the contrast between the visibility function of the two fruit surfaces. The observational method is done by observing the fruit and its defects under the various light sources. The required lighting in the packing plant installation is to be divided between general and supplementary lighting, according to the paper. The general lighting should be at least 10% of the total to assure eye comfort of the work, and the supplemental lighting should be such that it provides shadow-free, glare-free light on the working surface of the grading equipment. Also covered in the paper are: The effect of back-ground; a simplified practical procedure for determining quality and quantity; and the designing of the lighting system.

The Durability Test — A Key to Handling Wafers and Pellets, by M. Lee Gustafson, research engineer, The Farmhand Co., Division of Superior Separator Co., Hopkins, Minn. Paper presented at the Winter Meeting of the ASAE, at Chicago, Ill., December 1959, on a program arranged jointly by the Electric Power and Processing and Power and Machinery Divisions. Paper No. **59-621.**

Pellet durability, the ability of a pellet to withstand the rigors of mechanical handling and transportation, is said to be of as much concern to those involved in the development of forage pelleting machinery as to those in the pelleted feed industry. Pellet damage—particularly that which occurs between the time of manufacture of the pellet and the time of its end use—is a very real problem as already experienced in the feed industry. This paper deals with this problem and includes a discussion on the determination of a "yardstick" for measuring the severity of action of conventional and future handling equipment in handling pellets after processing. Also explained in detail are the nature of the damaging forces, the criteria for a practical test, test apparatus in use, dimensional specifications, speed of rotation, the definition of fines, designation or durability, use of rating, and the benefits of a standard test.

ASAE Division Program for ASEE Annual Meeting

The ASAE Division program at the Annual Meeting of the American Society for Engineering Education at Purdue University, Lafayette, Ind., is scheduled for the morning of June 20. The theme of this session will be "Continuing Education for Engineers after Graduation" and the presiding officer will be J. B. Liljedahl, associate professor, agricultural engineering department, Purdue University. The subject of "What Industry is Doing for Continued Education of Engineers" will be covered by E. F. Schneider, vice-president, farm equipment product planning, International Harvester Co., Chicago, Ill., and a discussion of the paper will be led by R. R. Raney, director of engineering, New Idea Division, Coldwater, Ohio. "Continued Education by Industry Contacts for Teachers" will be given by B. A. Stout, assistant professor, agricultural engineering department, Michigan State University, East Lansing, and a discussion of the paper will be led by G. W. Isaacs, associate professor, agricultural engineering department, Purdue University. The concluding paper on the program will be presented by C. G. E. Downing, head, engineering science department, Ontario Agricultural College, Guelph, Ontario, Canada, and will be on "Continued Education by Active Research for Teachers." T. W. Edminster, assistant chief, ARS, U.S. Department of Agriculture, Beltsville, Md., will lead discussion following the presentation of this paper.

Executive Changes in Farm Equipment Companies

Top executive changes have been announced recently by two major farm equipment companies.

Announcement has been made on February 1 of the election of William J. Grede to the presidency of J. I. Case Co. He succeeds Marc B. Rojtman, who has assumed the new position of special advisor to the president and the executive committee.

The resignation of Carl L. Hecker as president and director of The Oliver Corp. was announced January 26. He will continue to serve the company as a consultant. Alva W. Phelps, chairman of the board and chief executive officer, was elected president to serve until a successor to Mr. Hecker has been selected.

Ohio Rubber Company Plans Expansion

The Ohio Rubber Co., a division of The Eagle-Picher Co., plans to begin immediate construction of a new plant at Fort Smith, Ark., which will be 190,000 square feet in area. It is scheduled for completion around February 1, 1961. Initially employing approximately 250 people, its design will permit prompt and economical expansion expected at a later date. The Fort Smith plant will combine the newest engineering and manufacturing concepts in the mechanical rubber goods industry, and it will initially manufacture automobile floor mats; molded precision rubber parts for automotive, oil field, and general industry; and semi-pneumatic tires for industrial, agricultural implement and other applications.

Grain Drying and Storage Conference

The sixth annual Grain Drying and Storage Conference was held on March 2 and 3 at the Texas Technological College, Lubbock. A well-rounded program included seminars on grain drying, grain aeration, grain storage - structures, fans - controls-instruments, fumigation, and merchandising. The following ASAE members participated in the conference: W. S. Allen, agricultural engineer, farm structures specialist, Texas Agricultural Extension Service, Texas A. & M. College, College Station; Lloyd L. Hamilton, manager, agricultural division, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.; W. V. Hukill, agricultural engineer, in charge of grain storage investigations, ARS, USDA, Iowa State University; Fred W. Rabe, engineer, Dallas, Texas (heads his own engineering firm); and Ira L. Williams, head, agricultural engineering department, Texas Technological College, Lubbock.

MSAE Degree Approved at University of Maryland

Announcement has been made by R. L. Green, head of the agricultural engineering department, College of Agriculture, University of Maryland, that a graduate program for a Master of Science degree with a major in agricultural engineering has been approved. In support of this program graduate courses have been inaugurated to permit specialization in power or machinery, structures, application of electricity, mechanics of agricultural materials handling and processing, and soil and water conservation engineering.

Publishing Company to Test American Farm Equipment

United States Publishing Co. of Indianapolis, Ind., publishers of *Farm and Ranch Machinery Reports*, have signed a contract to test American farm equipment for Sotema, S. A., Argentine subsidiary of the Fiat Company of Italy. The FRM Reports are consumer reports on all types of farm equipment. The studies to be conducted for the South American corporation will be in the nature of comparative reports on specialized farm equipment, to enable the company to determine which type might best work out under South American farm conditions. The corporation will then apply for manufacturing licenses on recommended types. Cotton, corn, and wheat farming equipment will be among the types studied. J. Bruce Liljedahl, associate professor, agricultural engineering department, Purdue University, Lafayette, Ind., will be in charge of the research.

Cockshutt Appoints New U. S. Distributor

Cockshutt Farm Equipment Ltd., Brantford, Ontario, one of Canada's major producers of a full line of farm equipment has announced the appointment of the Frick Company of Waynesboro, Pa., as the exclusive distributor of all its products in northeastern United States. The Frick Company has a long history in manufacturing and distributing farm equipment, forestry equipment and related products, custom refrigeration and air conditioning installation.

Increase J. W. Schippmann Foundation Scholarships

Florida Ford Tractor Co., Jacksonville, has announced that the J. W. Schippmann Scholarships in agricultural engineering will be increased in value next year so that the two scholarships for seniors will be $700 and $400 each and the two for juniors will be $700 and $400 each. These four scholarships are awarded annually to students registered in agricultural engineering at the University of Florida. Recipients are selected by an agricultural engineering faculty committee in cooperation with the University Committee of Student Aid, Scholarships, and Awards.

EVENTS CALENDAR

March 15 — Sixth annual *Agricultural Marketing Clinic*, College of Agriculture, Michigan State University, Kellogg Center, East Lansing, Mich. Write to: John R. Moore, extension specialist, Agricultural Economics Dept., MSU, East Lansing, Mich., for information.

March 31 - April 1 — 41st *Annual Meeting* of *Dairy Industries Supply Association*, Edgewater Beach Hotel, Chicago, Ill. For further details write to DISA, 1145 19th St., N.W., Washington 6, D.C.

March 31 - April 2 — *1960 Farm Home Festival*, College of Agriculture, University of Illinois, Urbana.

April 3-8 — *1960 Nuclear Congress* with *1960 Atomic Exposition*, New York Coliseum, New York City. Additional information may be obtained from Engineers Joint Council, 29 W. 39th St., New York 18, N. Y.

April 8-9 — 17th *Western Section Conference, The Society of the Plastics Industry, Inc.*, New Riviera Hotel, Palm Springs, Calif. Additional information may be obtained by writing to SPI, 250 Park Ave., New York 17, N. Y.

April 12-27 — *Milan Trade Fair*, Milan, Italy. Write to Edward K. Moss, 1025 Connecticut Ave., N.W., Washington 6, D.C., for details.

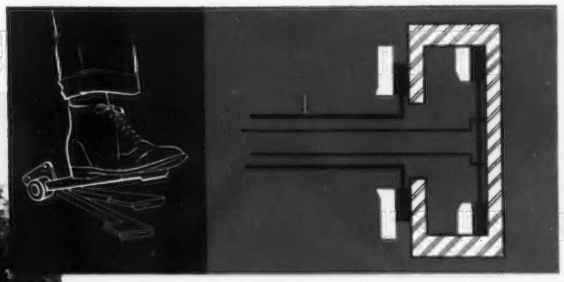
April 18-20 — *Seventh National Watershed Congress*, Washington, D.C. Write to The National Association of Soil Conservation Districts, Service Dept., League City, Texas, for further details.

April 19-21 — 15th *Annual Meeting* and *Lubrication Exhibit* of the *American Society of Lubrication Engineers*, Netherland Hilton Hotel, Cincinnati, Ohio. For further information address ASLE at 84 E. Randolph St., Chicago 1, Ill.

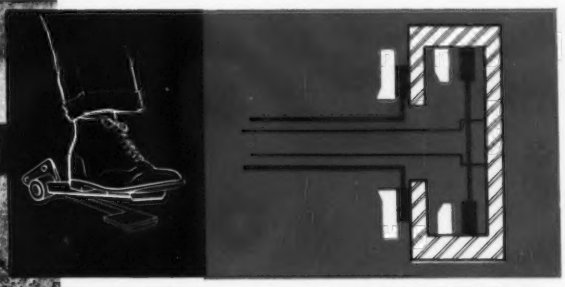
April 25-26 — 18th annual *Canadian Section Conference, The Society of the Plastics Industry, Inc.*, London Hotel, London, Ontario, Canada. For details contact SPI, 250 Park Ave., New York 17, N. Y.

April 25-29 — *American Welding Society's* 41st Annual Convention and Welding Exposition. Convention will be held in the Biltmore Hotel, and the Welding Exposition in the Great Western Exhibit Center, Los Angeles, Calif. For further details write Information Center, AWS, 33 W. 39th St., New York 18, N. Y.

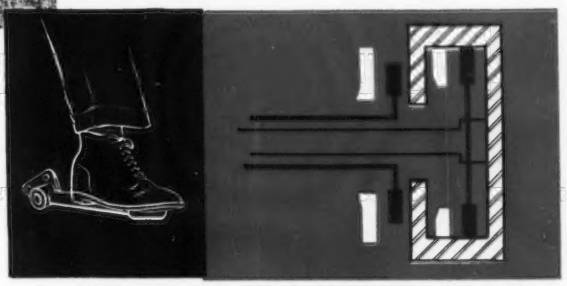
May 3-5 — 15th *Purdue University Industrial Waste Conference*, Memorial Union Bldg., Purdue University, Lafayette, Ind. Additional information may be obtained by writing to: D. E. Bloodgood, professor of sanitary engineering, Purdue University, Lafayette, Ind.



When the clutch pedal is not depressed, both the transmission and PTO clutches are engaged.



At the halfway mark (you can feel it) only the PTO clutch is engaged. The tractor stops.



When the clutch pedal is fully depressed, both the transmission and PTO drives are disengaged.

SPICER'S DUAL DRIVE TRACTOR CLUTCH . . .

Controls Both The Transmission And PTO With A Single Two-Stage Pedal

In the Spicer Dual Drive Clutch, both the transmission and the PTO drives are operated by a single two-stage foot pedal. This design leaves the operator's hands free at all times for safer steering, faster gear changes and precision implement adjustments.

For added efficiency, the tractor can be stopped while the PTO continues running . . . simply by depressing the clutch pedal to an easily recognized mid-point. This is a tremendous advantage to the farmer who is baling heavy windrows of hay, picking a high-yield stand of corn, or doing any number of tasks. For greatest safety, the tractor and PTO work may be instantly stopped by completely depressing the pedal.

Add to the safety and efficiency of your tractor design by incorporating a Spicer Dual Drive Clutch. The Dana engineers will be glad to help you with any clutch or transmission problem.

DANA Spicer

DANA CORPORATION

Toledo 1, Ohio

SERVING TRANSPORTATION AND AGRICULTURE —
Transmissions • Auxiliaries • Universal Joints • Clutches
Propeller Shafts • Power Take-Offs • Torque Converters
Axles • Powr-Lok Differentials • Gear Boxes • Forgings
Stampings • Frames • Railway Drives

Many of these products are manufactured in Canada by Hayes Steel Products Limited, Merritton, Ontario

C. L. Martin, Jr.

W. M. Hurst

Charles M. Merkel

Robert E. Perritt

Christian L. Martin, Jr., has been promoted from director of engineering research and development to general manager of The Fluidizer Co., a division of Superior Separator Co., Hopkins, Minn. He joined the company in 1957 and prior to that time was associated with Green Giant Co. in food processing development. A native of Pennsylvania, he received a B.S. degree in agricultural engineering from Pennsylvania State University and also served as a member of its agricultural engineering faculty.

W. M. Hurst, head of the USDA Cotton Ginning Research Section of AERD, ARS, Beltsville, Md., retired on January 31 after serving more than 33 years with the department. He joined USDA in 1926 as a junior agricultural engineer at Arlington Farms, Va. From 1938 to 1945 he headed fiber flax studies at Corvallis, Ore., and helped develop modern machinery for that industry in the northwest. He transferred to Beltsville in 1945 where he worked on equipment, plant layout, facilities, and operation of rural industries such as poultry processing, vegetable canning, and fruit handling. As head of the Cotton Ginning Research Section since 1952, he has been instrumental in making cotton fiber-quality testing an integral part of ginning investigations and has stressed close cooperation on regional studies of cotton ginning and mechanization.

Charles M. Merkel has accepted the position of vice-president in charge of engineering with Continental Gin Co. He formerly was in charge of the U.S. Cotton Ginning Laboratory, Stoneville, Miss., which is operated by AERD, ARS, USDA.

Robert E. Perritt has accepted a position as sales engineer with OPW Corp. of Cincinnati, Ohio. He previously was associated with International Harvester Co. as a service supervisor.

Albert H. Miller, formerly a sales engineer for Short and Brownlee Co., is now associated as manager with Albar Building Sales of El Dorado, Ark., constructors of steel buildings.

Benjamin J. Linthicum advises that he has accepted the position of sales engineer with Airpax Electronics, Inc. of Cambridge, Md. For several years he has been associated with Head Range Farm at Church Creek, Md.

Glenn M. Peterson is continuing in the sales and engineering field by accepting the position of regional manager for Orenda Industrial, Inc. He previously held the position of industrial sales engineer with The Oliver Corp.

Ralph M. Riekenberg has been made president of Buzbee-Thompson Steel, Inc. Formerly he was a production engineer with the AGT Division of Westinghouse Electric Co.

William M. Stader advises that he is located in Coldwater, Ohio, with Pax Steel Products, Inc., as a product engineer. Previously, he was associated with Opekasit, Inc. as an agricultural engineer.

Ralph A. Thompson recently has accepted the position of agricultural engineer with the transportation and facilities research division of the Agricultural Marketing Service, USDA, located at Purdue University, West Lafayette, Ind. Formerly, he was connected with the consulting engineering firm of Ammann and Whitney as soils engineer.

Walter L. Urie, formerly an agricultural engineer with the USDA Soil Conservation Service, is now affiliated with the highway construction firm of Burnett and Campbell Inc., Burlington, Vt., as an engineer.

E. I. Olson, formerly chief field engineer, has been appointed sales manager of the Industrial Division of Durkee-Atwood Co., Minneapolis, Minn.

Ernest Snavely has returned to the United States from Baghdad, Iraq, where under the auspices of the University of Arizona's ICA contract to provide professors in the key positions of the College of Agriculture, University of Baghdad, he supervised three professors in farm power and farm machinery and was head of the department of rural structures. He held a similar position at the American University of Beirut, Lebanon, from 1954 to 1957. His present position is that of chief product engineer for John Deere de Mexico plant in Monterrey. He formerly worked for John Deere as an experimental engineer from 1948 to 1954.

Gerald L. Zachariah, who has been a member of the Kansas State College staff as a research engineer in the agricultural engineering department, advises that he has joined the staff of Purdue University as an instructor in the agricultural engineering department.

Guy O. Woodward has resigned his post as extension agricultural engineer with the Federal Extension Service, USDA, Washington, D. C. to take a position with the Engineering Experiment Station, Utah State University, Logan.

George A. Crabb, Jr. writes that he is now located in Addis Ababa, Ethiopia, as deputy chief of USOM's Industry and Water Resources Program where he has served as acting chief for over six months. He accepted his first USOM overseas assignment to Sudan in 1959, where he assisted in the establishing of an educational program in that country. He served in the capacity of an educational advisor to the hydraulic and hydrologic training program and assisted with technical training in surveying and mapping.

W. Everett Eakin has been appointed assistant to the vice-president of public relations at Libbey-Owens-Ford Glass Co. He became associated with its public relations staff in 1946 and for more than a decade has been in charge of market development for thermopane insulating glass in livestock and poultry buildings. In his new capacity he will devote a major portion of his time to other public relations functions and will continue to serve as a liaison man in the agricultural field. Through his farm research program, he introduced the solar principle of design to farm buildings.

Absalom W. Snell, head of the agricultural engineering department at Clemson College, has received a National Science Foundation science faculty fellowship award covering 12 months, beginning in September, 1960.

Carl J. Turner has resigned as assistant director of the Clemson College Experiment Station and is now working with the Carolina Power and Light Co. in Florence as an industrial development agent.

Frank J. Westfall now holds the position of chief engineer with the San Antonio Construction Co. of Artesia, Calif. Previously, he was employed by the Subdivision Engineering Corp. of Pasadena, Calif., as a hydraulic progress engineer.

(Continued on page 195)

NECROLOGY

Arvy Carnes, an ASAE member since 1927, died in his Auburn, Ala., home on December 17 at the age of 67. Death was attributed to a heart attack. A native of Hamilton, Ala., he graduated from Hamilton, Agricultural School and received a B.S. degree from Auburn University in 1915. After studying at Cornell University and Auburn University he received an M.S. degree from the latter in 1929. He became a member of the Auburn University agricultural engineering department staff in 1924, and during 1936 and 1937 served as head of the department. In 1937, he joined the USDA Soil Conservation Service in Spartanburg, S. C., and served as chief of Regional Engineering Division 2, which included nine southeastern states, Puerto Rico and the Virgin Islands, until 1954. Since 1954 he served as state conservation engineer for the USDA, Soil Conservation Service in Auburn, Ala.

Arvy Carnes

He was a member of the Holy Trinity Episcopal Church in Auburn, the Lions Club, the Alpha Gamma Rho social fraternity, the Gamma Sigma Delta honorary agricultural society, and a charter member of the American Legion. His wife, Helen, survives.

It's easy to design with concrete

Quality construction for buildings of all types is based on simple design principles. Observance of these fundamental principles is the sure way to economical, attractive and durable farm structures.

This is the first in a series of reports that will show accepted design methods for concrete. Each will deal with one specific aspect of concrete construction, and the application of engineering principles.

Foundations . . . "a job well begun is half done"

Type: *Continuous foundations* are the most economical way to assure protection of the building contents from rodent damage. On small farm buildings continuous foundations are designed by "rule of thumb." The footing is made twice as wide as the wall thickness and of a depth equal to the wall thickness.

Spread footings are economical where the loads can be carried by columns or frames. Small spread footings are made half as thick as the side dimension of the footing.

Post and grade beam foundations are economical, in areas of extreme frost penetration. The post is designed to carry the entire load in end bearing on the soil. Frictional resistance of the soil on the post cannot be relied on.

Grade beams are designed as continuous members to carry loads to the posts. Moment is considered to be $1/12\ wl^2$. Since the beam does not extend below the frost line, stress reversals in the beams are likely to occur due to frost heave. The beam is reinforced for equal moment in both directions.

Size: The bearing value of the soil determines the foundation area needed. Test borings are the only sure way of determining actual foundation capacities. Farm structure designs are usually based on presumed bearing capacities for different soil types. Fig. 1 shows the range of bearing values commonly used. Knowing the load on the footing and the bearing capacity of the soil the size footing can be determined from solid lines on chart.

Depth: Foundations should always extend below the frost line. Shallow or floating foundations, as the name implies, are subject to movement. Soils that have thawed after freezing are often quite fluid and have poor bearing qualities. Frost heave is particularly serious with some soils, notably silts and loams.

Reinforcement: Continuous foundations for farm buildings need not be reinforced except in areas of unusual soil conditions. If reinforcement is used to control cracking, an area of steel equal to at least 0.0025 times the cross sectional area of the foundation should be used longitudinally. It should be equally distributed between top and bottom of the foundation wall.

Isolated footings smaller than 3 feet square are usually unreinforced. For larger footings the amount of reinforcing needed in each direction can be determined from the dotted lines of Figure 1, shown above.

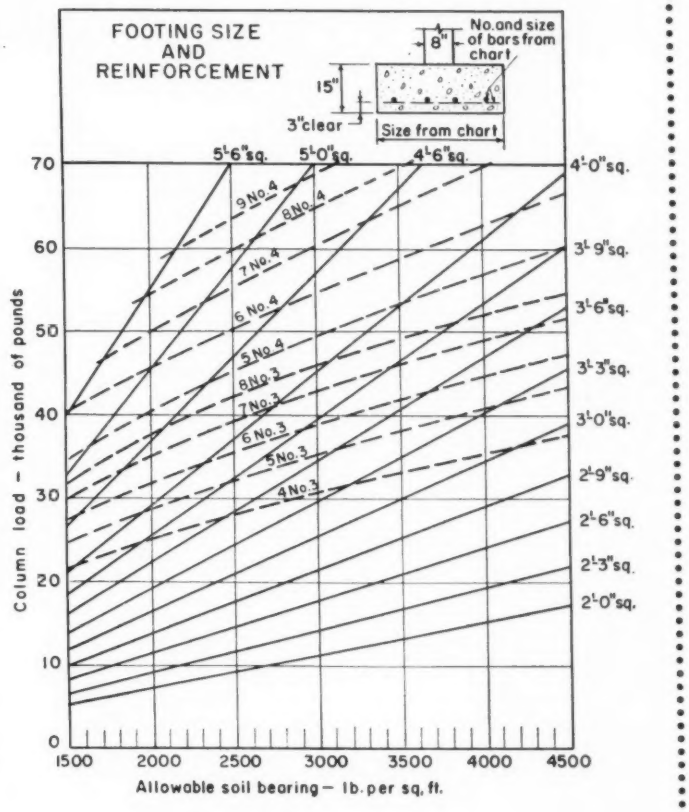


FIG. 1

Example: Assumed bearing capacity of soil = 4,000 p.s.f.
Assumed Column Load = 45,000 lb.
From Fig. 1: 3'6" sq. footing
From Fig. 1: Seven No. 3 ($^3/_8$" round) bars each way.

For more information on actual construction methods, write for free booklet, "*Building Concrete Farm Structures.*" Distributed only in the U.S. and Canada.

PORTLAND CEMENT ASSOCIATION

Dept. 3-1, 33 West Grand Ave., Chicago 10, Illinois

A national organization to improve and extend the uses of concrete

Robert Tweedy, chairman of the Iowa Section of ASAE, *(left)* greets Norval H. Curry, chairman of the Agricultural Section of the Iowa Engineering Society, when the two groups met jointly February 23 at Des Moines. *(Left to right)* Carroll Worlan, secretary, Iowa Engineering Society and in charge of local arrangements; Paul Jacobson, vice-chairman, Agricultural Section, IES; Tweedy; Curry; and Leon Charity, vice-chairman, Iowa Section of ASAE.

Iowa Section

The Iowa Section held a meeting on February 23 at the Hotel Fort Des Moines, Des Moines, Iowa, jointly with the Agricultural Section, Iowa Engineering Society, and in conjunction with the IES Annual Meeting. The afternoon IES program dealt with the professional aspects of the engineering profession and included discussions on "The Engineering Profession — Emerging from Adolescence," by Harold A. Mosher, president, National Society of Professional Engineers; "The Engineer's Part in Practical Politics," by W. S. Ginn, vice-president and general manager, Turbine Division, General Electric Co.; "Sell More Than Your Slide Rule," by O. C. McCreery, assistant to president, Aluminum Company of America; and "The Profession of Engineering," by Craig R. Kennedy, attorney-at-law.

A total of 82 persons attended the joint ASAE-Agricultural Section, IES evening session at which Patrick Grimes, research engineer, Allis-Chalmers Mfg. Co., gave an address on the fuel cell tractor, and H. Robert Veenstra, Stanley Engineering Co., spoke on "Professionalism Is for All Engineers." Robert Tweedy, chairman of Iowa Section of ASAE, announced plans for inaugurating an Iowa Section newsletter, and also that the next section meeting will be held at the Tallcorn Hotel, Marshalltown, Iowa, on April 29.

Florida Section

The Florida Section will hold its annual meeting on May 5-7, at Ellinor Village, Ormond Beach, Fla. The 1960 theme is "Florida Members Presentation of all Papers." McGregor Smith, chairman of the board, Florida Power & Light Co., Miami, will be the toastmaster, and the featured speaker at the banquet will be Joseph Weil, dean of the College of Engineering, University of Florida.

Rocky Mountain Section

April 1 and 2 have been announced as the annual meeting dates for the Rocky Mountain Section. The meeting will be held on the campus of New Mexico State University, University Park. During the technical program "Measurement of Soil Moisture by the Neutron Method" will be discussed by C. H. M. van Bavel, principal soil scientist, Waste Water Conservation Laboratory, Tempe, Ariz., and the subject of pneumatic conveying of materials will be discussed by Jesse E. Harmond, head, Small Grain Harvesting and Processing Section, ARS USDA, Corvallis, Ore. National President L. H. Skromme will be the featured speaker at the banquet.

Connecticut Valley Section

The largest attendance on record — 59 members and guests — was established when the Connecticut Valley Section held a dinner meeting on February 17 at the Yankee Pedlar Inn, Holyoke, Mass. L. H. Skromme, president of ASAE and chief engineer of New Holland Machine Co., was the featured speaker, and gave an interesting talk on the development of farm machinery in his company.

Washington, D. C. Section

The Washington, D. C. Section held a luncheon meeting on March 11 in the USDA South Building, 14th and Independence Ave., S.W., Washington, D. C. The speaker was Herbert N. Stapleton, whose topic was "Production Engineering in Agriculture."

Southwest Section

The Southwest Section will hold a meeting on March 24 and 25 at the Washington-Youree Hotel in Shreveport, La. Registration will begin on Wednesday evening, March 23. The Thursday morning session will be a Soil and Water program, the theme of which will be "Water Management." "Design of Floodwater Retarding Structures" will be discussed by Gene Vittetoe, while the subject of investigations of tile drainage in the Arkansas delta will be covered by Warren Harris. W. O. Ree will speak on hydraulic design of diversion terraces. I. L. Saveson will give a report on land conditioning and forming for drainage, and Jay Porterfield will discuss "Agricultural Engineering in Australian Agriculture."

The Thursday afternoon session will be devoted to Farm Structures, the theme to be "Functional Structures." The topics to be covered include: Application of stressed-skin panels for farm building construction, by G. L. Nelson; design of feed handling layouts for farm installation, by W. E. McCune; silo construction and handling of silage in horizontal above ground silos, by J. W. Sorenson; basic principles in fog cooling of shelters, by Thomas F. Maher; and a progress report on ASAE animal shelter ventilation committee work, by Hugh J. Hansen. A student program is also scheduled for Thursday afternoon. The featured speaker at the Thursday evening banquet will be C. O. Holland, president, Peoples Bank and Trust Co., Minden, La., and the evening's entertainment will be furnished by the Centenary College Choir, through the courtesy of the Southwestern Electric Power Co.

The theme of the Friday morning Electric Power and Machinery session will be "What's Coming in the 60's." J. P. Hollingsworth will speak on solid-state devices for agricultural applications; Glenn Nelson on electric house heating in Arkansas; Perry I. Isbell on factors influencing distribution patterns of boomless sprayers; Lambert Wilkes on ground spray rig design for cotton insect control; and E. J. Matthews, on parallel flame cultivation of cotton. A business session on Friday afternoon will conclude the two-day meeting.

Michigan Section

The winter meeting of the Michigan Section was held on February 12 at the Dearborn Inn, Dearborn, Mich. The varied program included discussions on methods being developed to harvest fruit, by R. P. Larsen, associate professor of horticulture, Michigan State University, and Jordan Levin, agricultural engineer, ARS, USDA; on ventilation designs for farm buildings, by J. Dewey Long, consulting engineer, Stran-Steel Corp.; on design and field problems of implements due to the advent of a 1000 rpm PTO shaft, by B. G. Rich, chief engineer, John Deere Waterloo Tractor Works; and on the recent developments in the use and application of agricultural chemicals,

(Continued on page 193)

ASAE MEETINGS CALENDAR

March 24-25 — SOUTHWEST SECTION, Washington-Youree Hotel, Shreveport, La.

April 1-2 — ROCKY MOUNTAIN SECTION, New Mexico State University, University Park, N. M.

April 8-9 — MID-CENTRAL SECTION, Hotel Robidoux, St. Joseph, Mo.

April 14-15 — PACIFIC COAST SECTION, Arrowhead Conference Center of the University of California.

April 22 — QUAD CITY SECTION, American Legion Club, Moline, Ill.

April 29 — IOWA SECTION, Tallcorn Hotel, Marshalltown, Iowa

May 5-7 — FLORIDA SECTION, Ellinor Village, Ormond Beach, Fla.

May 6 — MICHIGAN SECTION, Oliver Co., Battle Creek, Mich.

June 12-16—ANNUAL MEETING, Ohio State University, Columbus, Ohio.

August 22-23—NORTH ATLANTIC SECTION, University of Massachusetts, Amherst.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Coolness... efficiency... NOW—attractive colors, too!

Alcoa® Rib Roofing, in natural aluminum finish, diamond embossed for attractive appearance, and warranted against corrosion, is recognized as an ideal material for both pole buildings and for beautifying the farmstead. And now, you may also obtain Alcoa Colorib* Panels in seven baked-on enamel colors.

Heat-reflective aluminum helps reduce costly milk and egg production slumps. Because aluminum reflects solar heat, buildings erected with Alcoa Rib Roofing remain up to 15 degrees cooler—even on the hottest summer days—keep livestock healthier and more productive. And, because it is light in weight and easy to apply, aluminum roofing saves on erection costs—as much as 75 per cent on pole-type farm buildings!

ALCOA STANDARD RIB ROOFING OFFERS ALL THESE MONEYSAVING ADVANTAGES:

- Ribbed configuration provides high strength, to withstand heavy snowfalls and high winds when used on pole-type buildings
- Diamond embossed for attractive appearance and reduced glare
- A 30-year warranty against corrosion damage
- Permanent freedom from painting
- Siphon drainage, to prevent wind-driven side seepage
- Available in lengths from 6 to 18 ft; width provides 4-ft coverage

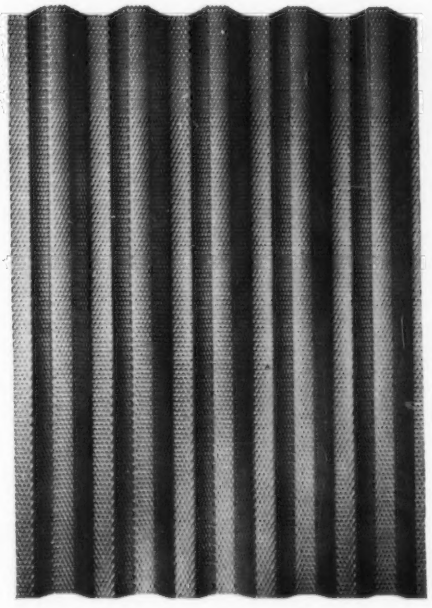
Alcoa Colorib Panels (white, gray, light or dark green, blue, red and gold) also offer 4-ft coverage, come in 8-, 10- and 12-ft lengths. Both Alcoa Rib Roofing in natural aluminum finish and Alcoa Colorib Panels are extremely suitable for carports, patio shades, playroom panels and many other applications around the farm, in addition to barns and other buildings.

*Trademark of Aluminum Company of America

Your Guide to the Best in Aluminum Value

For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and the Emmy Award winning "Alcoa Theatre" alternate Mondays, NBC-TV

ALCOA ALUMINUM



Let Alcoa answer your questions about how Alcoa Rib Roofing and other aluminum products can contribute to more efficient farming. For your convenience, use the coupon below to order informative booklets and leaflets for your files.

SEND FOR FREE LITERATURE TODAY

To aid you in your work with farmers, Alcoa provides a variety of information on farm applications of aluminum. Your requests for this material are welcome.

Agricultural Division, Aluminum Company of America, 1951-C Alcoa Building, Pittsburgh 19, Pa.

Please send items checked

☐ Alcoa Rib Roofing leaflet ☐ Alcoa 4-V Roofing leaflet ☐ One complete set of nine pole-building Steplans ☐ *Pole Barn Plans Catalog* . . . lists Alcoa plans available to farmers ☐ "Barn Raising, U.S.A.," 18-min sound-color film on pole-barn construction using aluminum roofing and siding† ☐ Alcoa Farm Gate literature . . . facts about aluminum gates.

†Films may be borrowed for public showing. Specify dates wanted.

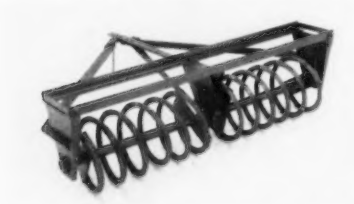
Name _____

Address _____

City _____ Zone _____ State _____

Spiral Coil Land Packer

International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill., has announced a new spiral coil land packer,



designed to leave a diagonal pattern in the soil and reduce direct water runoff at the end of furrows. Each revolution of the unit's coil leaves a complete pattern series providing holding areas for snow and water. The coil consists of a 1¼-in. steel bar coiled on edge in a continuous roll, spaced 5¾ in. apart and has a diameter of 18 in. The packer is available in sizes of 4, 5, 6 and 7 ft.

Hydraulic Shutter Control on Fertilizer Spreaders

New Idea Farm Equipment Co., Coldwater, Ohio, has announced a new hydraulic shutter control attachment, available for the

company's line of 8, 10, and 12-ft fertilizer and lime spreaders. A special double-acting cylinder makes it possible to open and close the shutters hydraulically rather than manually. A conversion kit is available to farmers now owning spreaders with manual shutter control.

New Flexible Shafts

The Stow Mfg. Co., 39 Shear St., Binghamton, N. Y., has announced two new heavy duty power drive flexible shafts. The

S100 flexible shaft has a 1-in. diameter core and reportedly will transmit up to 760 in.-lb of torque at 600 rpm. The S125 flexible shaft has a 1¼-in. diameter core, and is designed to transmit up to 1650 in.-lb of torque at 500 rpm (about 10 hp).

The heart of this flexible shaft is a core made up of layers of tightly wound music wire. The flexible casing is lined with oil tempered spring steel, reinforced with wire braid, and covered with an oil-resistant, neoprene-impregnated fabric and an abrasion-resistant rubber jacket. If desired, extra reinforcement can be put on one end or both.

Mobile Trencher

P-M Machine Co., 622 Carson St., Bryan, Texas, has announced new improvements in its line of ditching machines. Features in-

clude reversible block links and non-rotating roller pins in the bucket line assembly for reduced wear; a hydraulic crumbing shoe which is overload protected; hydraulic leveling bars which permit vertical ditches on slopes up to 15 deg; and an endless, reversible rubber conveyor with self-cleaning rollers and adjustable speed for conveying excavated material to the side.

The model can be mounted on a truck and because of its mobility is especially adapted for underground cable installations, irrigation and drainage tile. It is designed to dig ditches of 9½ in. to 30 in. in width, with depth down to 9 ft or more, depending on size of bucket-line and extension of the boom. A brochure giving specifications is available upon request from the manufacturer.

Bale Carrier System

New Holland Machine Co., New Holland, Pa., has developed a new bale carrier system, designed for automatic bale han-

dling. The new unit has a remote-control unloading device with a bale locator that can be moved back and forth on the conveying section, tipping bales off the conveyor automatically on either side and at any point in the mow. Bale discharge point and direction can be controlled with a rope from the ground.

All components are designed as separate "building blocks" and may be assembled to fit a variety of bale-moving jobs.

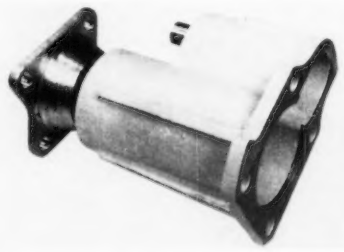
New Electronic Switch

Schacht Electronic Mfg. Co., 1213 Saint Emanuel, Houston 3, Texas, has introduced a small, versatile automatic light-operated

electronic switch for turning lights on at dusk and off at dawn automatically. The new switch is 1¾ in. in diameter and is suitable for installation in existing lighting fixture canopies, outlet boxes, post lanterns and in conjunction with mercury plunger-type relays for control of heavier electrical loads. It is designed to turn on at approximately one ft-c (foot-candle) and off at 10 ft-c.

New Truck PTO

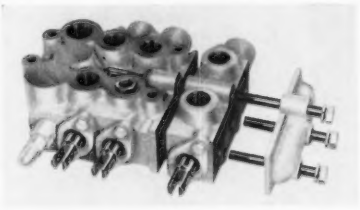
Standard Equipment Division, Dana Corp., 253 Waggoner Blvd., Toledo 12, Ohio, has announced a new power take-off



that mounts directly to the rear of transfer cases used in late model trucks with 4-wheel drive. With the main transmission in direct drive, the unit reportedly operates at 77 percent of engine speed and is said to be capable of transmitting full engine torque.

New Hydraulic Valve

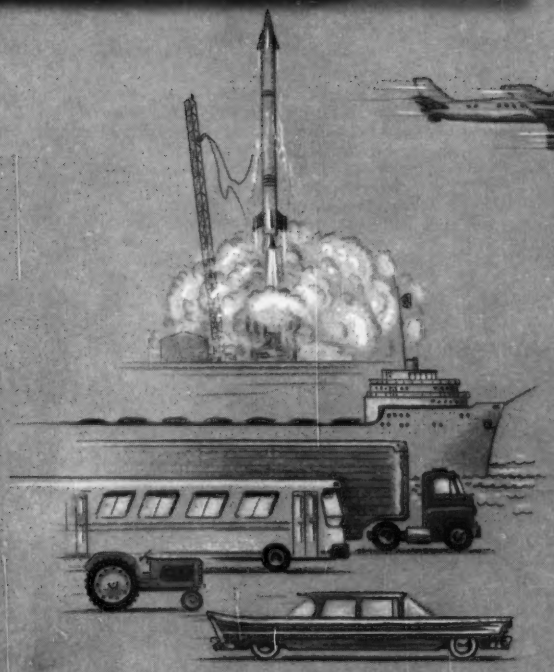
Hydreco Division, The New York Air Brake Co., 9000 E. Michigan, Kalamazoo, Mich., has announced a new V-34 series



general purpose hydraulic valve employing the sectional principle, designed for use on lift trucks and other mobile equipment where supplementary operations are frequently added to standard models.

The new valve is composed of a two-plunger cast-in-block section with integral pilot-operated relief valve. Complete description and performance details are included in Bulletin 12-160.1, available from the company.

(Continued on page 188)

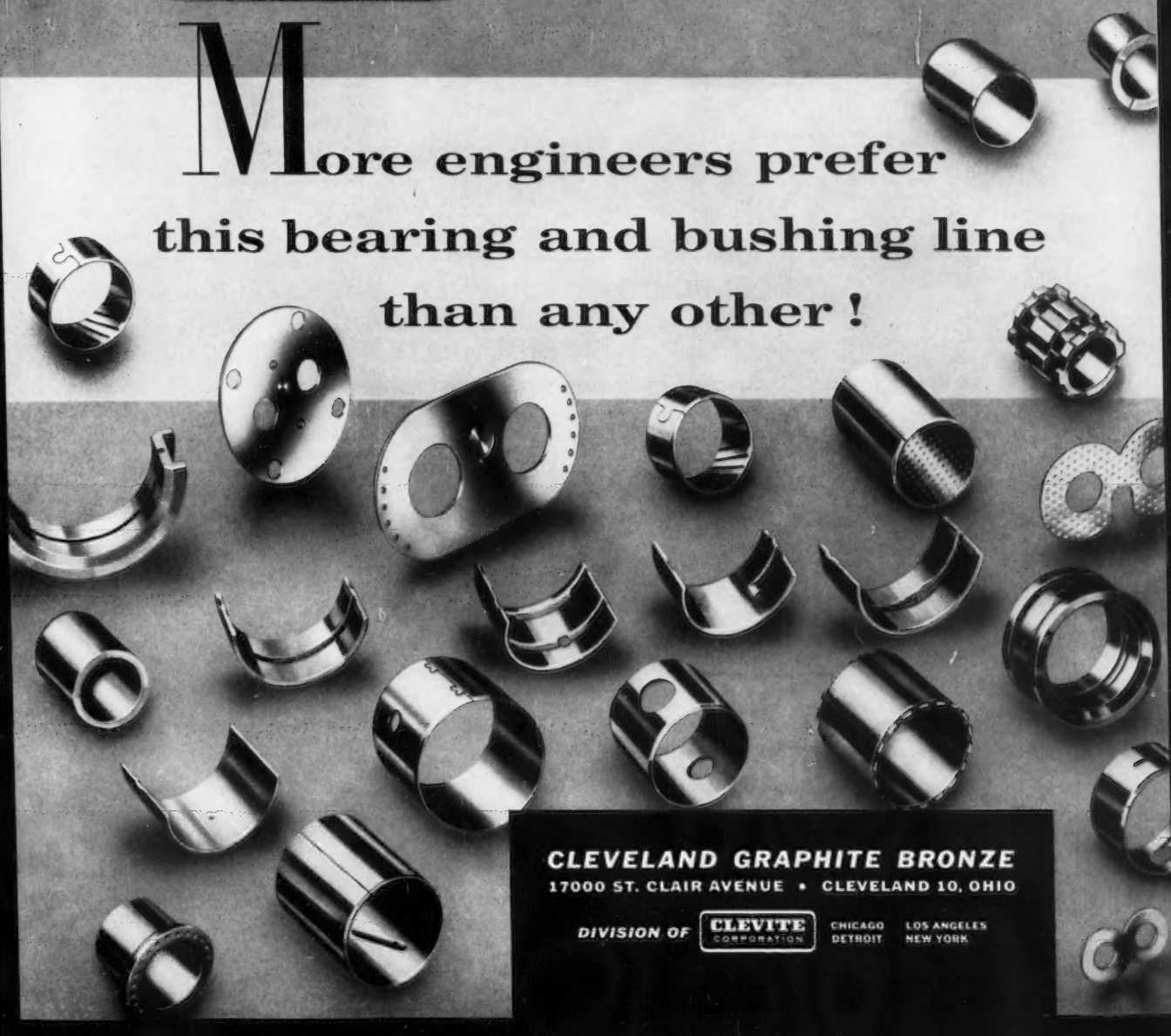


Engineers who specify original equipment bearings for most American cars, trucks, tractors, construction equipment, aviation-missle equipment, and Diesel and marine engines prefer Cleveland Graphite Bronze for reasons like this . . . They know CGB has pioneered in bearing and bushing design, having designed and introduced the majority of types now in use. *You are assured of a bearing, bushing or washer engineered to your specific application.*

Add to this the skill of CGB as a high quality precision manufacturer—with many exclusive production techniques. The continuous casting of babbit or copper-lead to steel strip is just one example. *Engineers are thus assured of top performance—long, trouble-free life.*

For prompt attention to your application—write, wire or phone—a qualified engineer will work with you.

More engineers prefer this bearing and bushing line than any other!



CLEVELAND GRAPHITE BRONZE

17000 ST. CLAIR AVENUE • CLEVELAND 10, OHIO

DIVISION OF CLEVITE CORPORATION

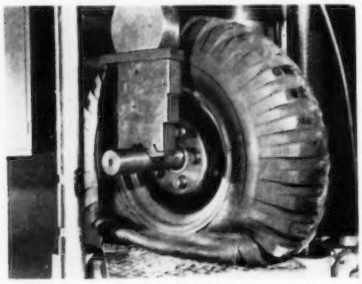
CHICAGO DETROIT LOS ANGELES NEW YORK

. . . New Products

(Continued from page 186)

Lightweight Aluminum Wheel

Motor Wheel Corp., Lansing, Mich., has introduced a new rolled-aluminum, disk-type truck wheel designed to combine



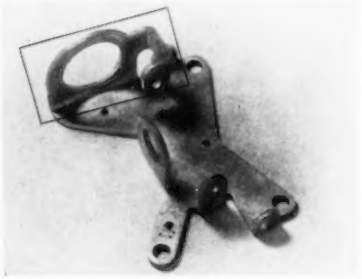
strength and light weight. The 18 x 11-in. rolled-aluminum wheel was designed and manufactured for use by the U.S. Army and reportedly can withstand a static load of 25,000 lb. Each wheel weighs 28 lb, which is said to be 25 lb less than a steel wheel of the same size.

New Joist Hanger

Timber Engineering Co. (TECO), 1319 18th St., N.W., Washington 6, D.C., has designed a new joist hanger for use with 2 x 4-in. members. The new hanger makes use of nails in shear and is manufactured of 18-gage, corrosion resistant steel. It is 3¼ in. high with a joist seat measuring 3⅜ in. in width and 1½ in. in depth. Special nails of 11-gage wire, fully barbed, and 1¼ in. long are furnished with each carton of hangers.

Rapid Part Production

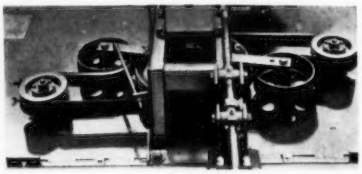
Federal Tool and Mfg. Co., 3719 Alabama Ave., Minneapolis 16, Minn., has developed a system called rapid-phase tool-



ing for manufacturing farm equipment parts and equipment in low production runs of 10 to 10,000 parts. The system is said to make available high quality precision parts without the cost of permanent tooling. In production all possible portions of the operation are done with tools and dies carried in stock and only the detailed parts of the die are made to specifications. Further details may be obtained by writing to the manufacturer.

Three Belts Replace Six

Dayton Industrial Products Co., 2001 Janice Ave., Melrose Park, Ill., has an-

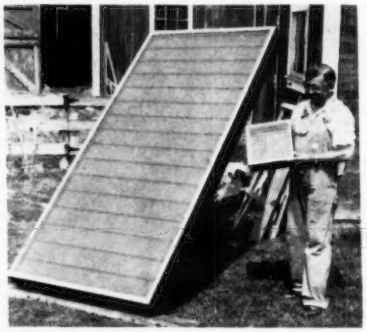


nounced development of a three-belt system to be used in place of 6 V-belts customarily used for operation of a mower-shredder. The mower-shredder is attached to the tractor PTO and power is transmitted through three-grooved sheaves by means of the V-belts which turn the spindles and twin free-swinging cutting blades.

The belt manufacturer reports that field tests have shown that these belts absorb shock loads better than a direct drive, last almost twice as long as conventional belts, and provide for simple maintenance and adjustment. Back slide idler pulleys on either side of the center sheave control V-belt tension and can be adjusted by loosening or tightening a single nut.

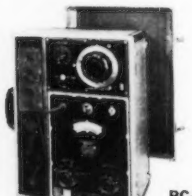
Solar Collector Plate

John A. Martin & Co., P.O. Box 637, Sheboygan, Wis., has developed a solar collector plate that is made in 4-ft by 8-ft



units. The manufacturer states that the use of multiple units offers many applications on the farm. These units are movable so as to be of use from season to season for various purposes, including crop drying in

BN-2


RC-12C1P

RD-15

CONDUCTIVITY EQUIPMENT FOR TESTING SOIL

Measure moisture content and soluble salt or fertilizer content with easy-to-use Industrial Instruments Conductivity Bridges!

BOUYOUCOS TRANSISTORIZED MOISTURE METER . . . designed for simple, rapid field testing of available soil moisture. Connect meter to leads from buried soil blocks and read moisture content directly. Completely self-contained, uses 4 inexpensive penlight batteries lasting 2 years. Second meter scale calibrated in ohms measured resistance. BN-2 Meter complete with neck strap and batteries **$96.00**

Gypsum Soil Blocks—impregnated with plastic for extra-life. Stainless steel electrodes and 5 ft leads . . . . . CEL-WWD—each **$2.20**

MODEL RC-12C1P SOIL MOISTURE BRIDGE . . . high accuracy research instrument incorporating true Wheatstone Bridge circuit with 1000 cps bridge oscillator. Range 0.2 to 2,500,000 ohms with 1% accuracy except at extreme ends of scale. 84" effective scale length and built-in adjustable capacitance up to 21,000 mmf. Electron "eye" null indicator and earphones. Battery-operated and contained in portable carrying case **$288.25**

SOLU BRIDGE SOIL TESTER MODEL RD-15 . . . for laboratory testing of soil extract conductivity and particularly valuable for use by flower growers and in greenhouses. Simplest and easiest to use, the RD-15 is an AC Wheatstone Bridge, line operated, "eye" tube used for null indicator. Calibrated 10-1000 **mhos** x 10^{-5}. Manual temperature compensator 50-100°F. In gray wrinkle steel case, for 115V/50-60 cycle AC operation **$78.00**

Conductivity cell CEL-S2—sturdy molded polystyrene dip cell **$19.25**

For complete details on these and other conductivity soil testing instruments and accessories write to...

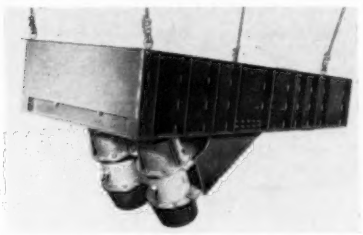
Industrial Instruments:

89 Commerce Road — Cedar Grove — Essex County — New Jersey

summer and fall and space heating of farm structures in winter. The company expects to be in production of the units late in 1960.

Adds to Feeder Line

Link-Belt Co., Prudential Plaza, Chicago 1, Ill., has announced the addition of 49 new sizes, in two motor capacities, to its



line of motorized counterweight vibrating feeders. With the new additions the company now offers more than 60 sizes with capacities up to 1700 tons per hr. These machines are compact, low headroom devices designed for feeding a wide range of bulk materials — from heavy, sticky ores to light, dry grains — at a uniform rate from bins, hoppers, storage piles or conveyors.

A completely new line of MC twin-motor feeders (shown) that includes 31 sizes with capacities from 275 to 1700 tons per hr has been added. The 18 new single motor feeders range in capacities from 5 to 525 tons per hr. Size ranges now include feeder lengths from 5 to 1700 tons per hr.

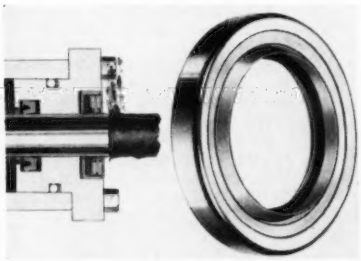
Slide Rule Watch

The Watchmakers of Switzerland, manufacturers of many specialized time pieces, have recently designed one of interest to

engineers. The new innovation is a slide rule watch that multiplies, divides and takes the cube root. For further information, write to Win Nathanson and Associates, Inc., 60 E. 42nd St., New York 17, New York.

New Rod Wiper-Scraper

Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago 22, Ill., has developed a new rod wiper seal that incorporates both a rod



wiper and a rod scraper within a single unit. The unit is designed to provide protection for packings on reciprocating shafts and hydraulic cylinders exposed to heavy dirt conditions. In operation the scraper removes frozen or caked mud, tar and other materials firmly stuck to the rod. The seal consists of a thin brass scraper ring in tandem with a pliable Sirvene (synthetic rubber) wiping member, both firmly clamped within a compact steel shell.

Corrosion Resistant Blower Wheels

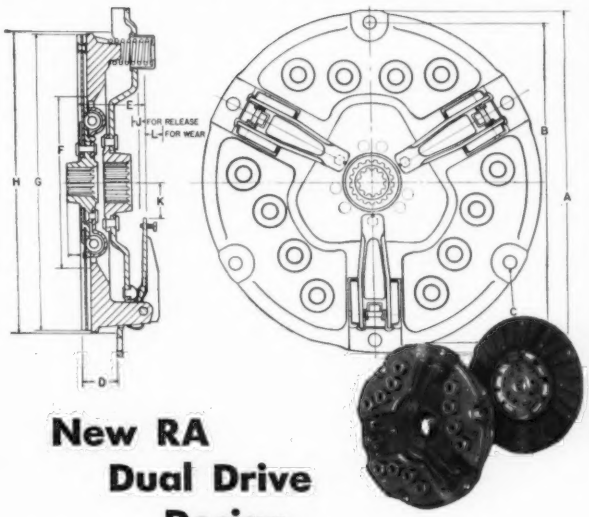
Morrison Products, Inc., 16816 Waterloo Rd., Cleveland 10, Ohio, has developed a new line of porcelainized enamel blower wheels and assemblies designed to provide resistance to corrosion. The porcelainized (glass-coated) wheels are designed for process equipment, air-conditioning equipment, cooling towers, evaporative condensers, air washers and other applications where corrosion or abrasion may be present. Wheels are available in 10 in. through 20 in. sizes, in capacities to 12,000 cfm. Corresponding porcelainized housing and bearing brackets can also be supplied.

Water Weed Control

Shell Chemical Co., 50 W. 50th St., New York 20, N. Y., has announced a new product for the control of submersed water weeds that choke irrigation canals and ponds. The product, Aqualin Herbicide, is a water-soluble liquid that is added to canal water with the use of specially designed equipment. The wave of herbicide-treated water thus formed is carried downstream, reportedly killing weeds as it moves.

Application methods and dosages vary according to canal or pond size, water temperature and density of weed growth. As an example, it is reported that 15 parts per million for 5 hr may control weeds for as far as 20 miles downstream.

ROCKFORD



New RA Dual Drive Design

This NEW ruggedly constructed, foot controlled, spring-loaded clutch transmits power to the power take-off or auxiliary drive by a hollow shaft, driven by a splined hub in the clutch cover plate. This hollow shaft rotates at all times the engine is running. The vehicle transmission shaft operates inside the hollow shaft. This makes the power transmission to drive the tractor, completely independent of the power take-off or the auxiliary drive. ROCKFORD CLUTCH engineers will help you make your farm machines more efficient and economical.

Small Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Power Take-Offs

Automotive Spring Loaded

BW SEND FOR THIS HANDY BULLETIN
Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

ROCKFORD Clutch Division BORG-WARNER
1325 Eighteenth Ave., Rockford, Ill., U.S.A.
Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

CLUTCHES

Primer of Lamps and Lighting, by Willard Allphin. Cloth. 6¼ x 9½ in. xi + 241 pages. Illustrated and indexed. Published by Chilton Co., Book Division, 56th and Chestnut Sts., Philadelphia 39, Pa. $10.00.

This book contains data on incandescent, fluorescent, and mercury lamps — how they work and where to use them, and how to make lighting calculations and layouts. It is directed particularly to lamp bulb and lighting salesmen, countermen, electrical contractors, students, building maintenance superintendents, electrical foremen, architects, and for the high school science bookshelf. Included is a lighting calculator slide rule for applying the lumen formula and for determining room area and room ratio for both direct and indirect lighting.

Vocational and Professional Monographs—No. 14 Engineering, by Edward H. Robie. Paper. 6 x 9 in. 36 pages. Published by Bellman Publishing Co., P.O. Box 172, Cambridge 38, Mass. $1.00.

This is one in a series of vocational and professional monographs and is for use in connection with guidance activities wherever general counseling work is conducted and for individual reference purposes in the choice of a career. It includes material on: History of the occupation or industry; qualifications for employment; training required; methods of entry; opportunities for advancement; earnings; general trends in the occupation or industry; and sources of further information.

Soil, Grass and Cancer, by Andre Voisin. Cloth. 5½ x 9 in. xvii + 302 pages. Illustrated and indexed. Published by Philosophical Library, 15 E. 40th St., New York 16, N. Y. $15.00.

In a series of concise and precise chapters this book reviews the roles of various soil elements, and at the same time their role in the formation of certain organic elements necessary to the life of the cell is studied. The principal theme is to show how the variations in these elements bring about metabolic disorders which are translated into pathological states, such as tetanies, certain enzootic ataxias, diarrhoea, anemia, etc. in the animal, and in man, tuberculosis, goitre, thromboses, diabetes and, above all, cancer.

Hydroponics — Bengal System, Third Edition, by Sholto Douglas. Cloth. 5 x 7½ in. x + 143 pages. Illustrated and indexed. Published by Oxford University Press, 417 Fifth Ave., New York 16, N. Y. $1.85.

Hydroponics, the soilless cultivation of plants, provides impressive crop yields on roof tops, in city gardens and back yards, and in areas where orthodox soil culture is uneconomic. The author is the originator of the Bengal system of hydroponics, and this book gives full instructions for the setting up of apparatus, the choice of aggregate and formulae, and the general technique of soilless culture.

Progressive Farming in Japan. Cloth. 7¼ x 10½ in. 150 pages. Published by Shin Norin Sha Co., Ltd., Tokyo, Japan.

This is the third book of a series following farm mechanization in Japan and is a compilation of photographs on Japanese farming aimed to contribute toward the establishment of a mechanized agricultural system in the country.

Farm Electric Sales Handbook. In loose-leaf form, contained in a sturdy, semi-flexible binder. 4½ x 7½ in. 66 pages. Published by Edison Electric Institute, 750 Third Ave., New York 17, N. Y. $3.50, plus postage.

This handbook is designed for use by rural salesmen of electric power companies, electric equipment manufacturers, agricultural extension services of colleges and others. Subjects covered include: Sprinkler irrigation systems, under-floor electric heating cable, heating cable to prevent pipes from freezing, electric equipment for the farm shop, electric dairy equipment, electric brooding and egg cooling and storage. Several useful tables are also included.

Electrical Efficiency in Industrial Plants, by Edwin S. Lincoln. 6 x 9 in. 235 pages. Illustrated. Published by F. W. Dodge Corp., 119 W. 40th St., New York 18, N. Y. $9.50.

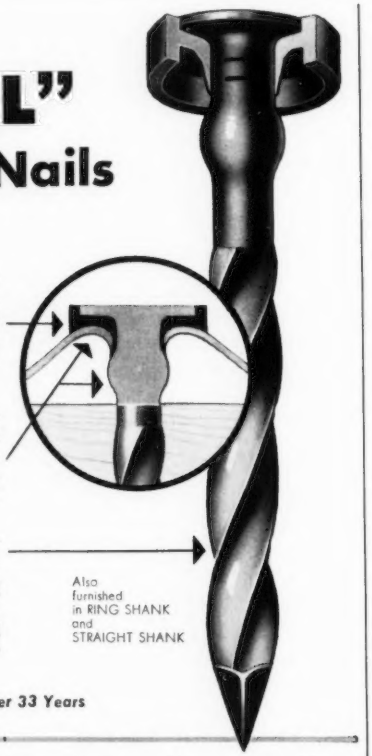
This handbook is a practical engineering guide to lower power costs and attacks specifically the problems of reducing electric power and lighting costs in industrial plants and large commercial buildings. It tells how to make surveys of load, power factor, voltage, lighting, wiring and electric protection. All necessary instruments are discussed in detail and a full analysis of power costs is included. Diagrams, tables and check lists supplement this book.

DENISTON

"LEAD-SEAL"

Metal Roofing Nails

GALVANIZED FINISH ONLY



LEAD SEAL—The *only nail* with lead just under the head and down the shank. When the nail is driven, the hole around the nail is plugged with lead and the break in the metal is completely covered, to form a perfect double seal.

TRIPLE LOCK—The *only nail* that has a locking bump. As the "bump" is forced through the sheet, the sheet springs back over the bump—this effectively prevents the nail from working out. The nail, lead and sheet are solidly locked together

DRIVE SCREW SHANK—The *only nail* that is driven on the steel head. Drive screw shank makes the nail turn and hold like a screw. It holds with a powerful, unyielding grip. Threads are deep and sharp because they are formed after galvanizing.

Accepted Standard of Quality for Over 33 Years

DENCO Lead-Head Metal Roofing Nails

BRIGHT OR GALVANIZED

6,000 pounds of pressure is used to compress the lead *cold*, both *over* and *under* the steel head of the nail as well as *down the shank*. The lead forms a perfect seal in the hole made by the nail. Heads will not "pop" off from expansion and contraction of roofing nor from wind vibration.

Shipped in 50 lb. cartons. Descriptive literature will be sent immediately upon request.

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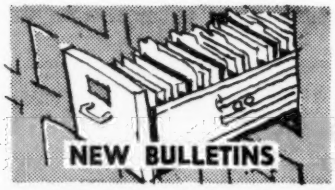

The following bulletins have been released recently. Copies may be obtained by writing to author or institution listed with each.

Hand Sprayers and Dusters, by Frank Irons. Home and Garden Bulletin No. 63, December 1959. Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price, 10 cents.

Soil Erosion Prevention on Bauxite Strip-mined Soils in Hawaii, by Bessel D. van't Woudt. Technical Progress Report 123, November 1959. Hawaii Agricultural Experiment Station, University of Hawaii, Honolulu, Hawaii.

When to Expect Late-spring and Early-fall Freezes in Kansas, prepared by L. Dean Bark. Kansas State Distribution Center, University of Kansas, Manhattan.

Cost of Operating the Pull-Type Three-Hopper Fertilizer Spreader, by Harold G. Walkup and Joe E. Fuqua. Circular 564 (Filing Code: 11). University of Kentucky, Cooperative Extension Service, Agriculture and Home Economics, Lexington.

The following test reports may be obtained from The British Society for Research in Agricultural Engineering, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, England:

No. 223 — *Fordson Dexta Diesel Tractor*
No. 224 — *"Micronette" Hand-Propelled* Sprayer
No. 225 — *"Hardy-Spicer" Power Take-Off Safety Guard*
No. 226 — *Holbaek Type GA Mounted Spinner Broadcaster*
No. 227 — *Lundell "40" Forage Harvester*
No. 228 — *Cary-White Grain Elevator*
No. 229 — *Cary-White Grain Conveyor*
No. 230/BS — *Fowler Challenger 33 Diesel Crawler Tractor*
No. 231 — *New Holland Hayliner "68" Pick-up Baler*
No. 232 *"Atko Teleplastic" P.T.O. Safety Guard*
No. 233 — *Wolseley "Multi-Mill" (Combined Hammermill and Mixer)*
No. 234/BS — *International BTD-20 Diesel Crawler Tractor*

Gas-Shielded-Arc Welding. 78-page book. Available at the American Welding Society, 33 W. 39th St., New York 18, N. Y. Price, $1.50.

Water's Role in Plant Location. 8-page analysis. May be obtained from the Water Information Center, Inc., 60 E. 42nd St., New York 17, N. Y. Price, $2.00.

Evaluation of Some Irrigation Water Control Devices, by Rhys Tovey and Victor I. Myers. Bulletin No. 319, December 1959. Idaho Agricultural Experiment Station, Department of Agricultural Engineering, University of Idaho, Moscow.

A Bibliography of Farm Buildings Research, 1945-1958 — Part 1 Buildings for Pigs. Available from Agricultural Research Council, 15 Regent St., London, S.W. 1, England. Price, 2s. 6d.

ACME'S SUPER Performance Roller Chains for

- STRENGTH
- DEPENDABILITY
- ENDURANCE

Just a few of the 35 chain drives illustrated in ACME's new catalog.

ACME Chains are designed and engineered to deliver positive power transmission and perform each specific job with maximum efficiency and economy. Sprocket ratio, chain impact, tension, drive speed and other factors are determined, not on the drawing board alone, but in the field where ACME Engineers observe and test chains at work while new equipment is being designed. In that way, ACME Chains are made to deliver positive power transmission with economy and dependability under all loads at all times.

ACME Engineers are constantly at your service — just write or phone Holyoke, JEfferson 2-9458.

WRITE DEPT. 9-T *for new 100-page illustrated catalog, including new engineering section showing 35 methods of chain adjustments.*

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

Call ACME for Service

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

MANUFACTURERS' LITERATURE

Literature listed below may be obtained by writing the manufacturer.

Land Preparation Booklets

Caterpillar Tractor Co., Advertising Division, Peoria, Ill. — Publication of three booklets on land preparation is announced:

Form No. D917, a multi-section, illustrated brochure titled "Build 'em Parallel," itemizes the ways in which parallel terraces speed up such farming operations as planting, cultivating, and harvesting.

Booklet No. D940, a 12-page, illustrated brochure titled "Long-Term Opportunities on the Great Plains Today," tells the story of what has been done and what still needs to be done throughout much of the Great Plains.

Booklet No. 33454, an 8-page, illustrated brochure titled "Small Watershed Program is Paying Off," contains case histories from several areas in which the problems have been solved.

Extruded Aluminum

Precision Extrusions, Inc., Green St., Bensenville, Ill. — A 12-page, illustrated brochure, Technical Bulletin No. 5909, contains latest information and descriptions on aluminum alloys and the aluminum extrusion process, as well as information on mechanical properties, recommended uses, and reference numbers.

Solar Buildings

Libbey-Owens-Ford Glass Co., 608 Madison Ave., Toledo, Ohio — Two booklets — one entitled "From Cradle to Gravy" (Form No. TP-37) and the other entitled "This Is the House that Jack$ Built" (Form No. TP-38) — describe and illustrate how wintertime sun heat is trapped by a south-facing wall of farm thermopane insulating glass, and along with controlled ventilation, goes to work inside the building to control moisture, reduce harmful temperature changes, and minimize labor costs for solar hog housing and dairy barns. Form No. TP-37 contains a layout of a typical modern sun-heated farrowing house and nursery building, while Form No. TP-38 contains photos of the interior of a solar dairy barn.

Insulated Thermocouples and Extension Wire

Research Instruments, Inc., 12410 Triskett Road, Cleveland 11, Ohio — 4-page illustrated brochure, Catalog No. 101, describes metalic sheathed, hard packed, inert oxide insulated thermocouples and extension wire. Listed are optional thermocouple terminals, and optional fittings in chart form. Also illustrated are thermocouples with hot junctions, bare wire and open end extensions, as well as diameter sheaths and random lengths with diameters from 0.040 in. to 0.250 in. Prices and ordering instructions are also given.

Shell and Tube Heat Exchangers

The Young Radiator Co., Racine, Wis. — 15-page, 2-color catalog No. 1258A presents data on copper base alloy, steel and stainless steel fixed tube bundle heat exchangers, and includes single-pass, two-pass and four-pass models for cooling water and oil in fresh or salt water applications as well as specially engineered heat exchangers for heating or cooling liquids and gases. Tables are listed showing pressure ratings and material specifications for steam service heat exchangers. An oil viscosity graph, a table of weights and dimensions are also included.

Picture Window Milking Parlor

Babson Bros. Co., 2843 W. 19th St., Chicago 23, Ill. — A 4-color booklet on the picture window milking parlor describes and illustrates the Surge six-point dairying system consisting of a comfortable loafing area; hospital and herd replacement area; push-button, automatic feeding; clean, hard-surfaced lot; enclosed holding area; and picture window parlor milking.

50th Anniversary Brochure

Victor Mfg. & Gasket Co., 5750 W. Roosevelt Road, Chicago 50, Ill. — A brochure entitled "50 Years in Sealing Products" is an anniversary historical profile following the company's growth from 1909 to 1959, including the people behind the product in the office, plant, sales and distribution front.

On-Farm Drying Booklet

Butler Manufacturing Co., 7400 E. 13th St., Kansas City, Mo. — Booklet entitled "Wet Years or Dry . . . on-farm drying pays every year" describes and illustrates pre-engineered drying systems. Suggested plans for installation of "Stor-N-Dry" bin drying centers and batch drying centers featuring push-button grain handling are also shown in the booklet.

Farm Motors

General Electric Co., Schenectady 5, N.Y. — Bulletin GEA-7022, a 10-page, 4-color publication, describes and illustrates line of farm motors in ⅛ through 5-hp ratings. It gives typical performance characteristics including charts on torque relationships and low temperature operation. Construction features are discussed and a table comparing capacitor farm motors with conventional repulsion-induction motors is included.

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Only Rain Bird irrigation sprinklers have all the advantages that have made them famous the world over. Every Rain Bird sprinkler advancement has been field-tested . . . and in the field, Rain Birds never have been surpassed. For top yields . . . top quality . . . there's no substitute for Rain Bird sprinklers.

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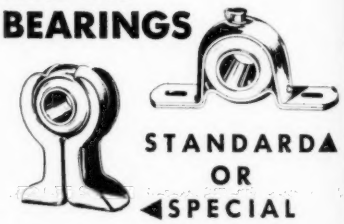

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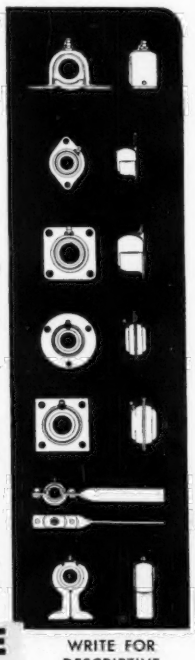

WRITE FOR DESCRIPTIVE LITERATURE

Fluorocarbon Resins

E. I. du Pont de Nemours & Co., Inc., Polychemicals Department, Wilmington 98, Del. — Bulletins Nos. M-6 and M-7, in a series of mechanical design floating rings, describe and illustrate where TFE fluorocarbon resins are used in mechanical seals, and the design of piston rings made with TFE resins.

Weld Fasteners

Ohio Nut and Bolt Co., 33 First Ave., Berea, Ohio — A 50-page book, Stock Parts Catalog 60 is designated as a combination catalog and welding manual. In addition to the dimensional information on stock weld nuts, weld screws, special purpose weld parts and leg levelers, the catalog has been expanded to include welding information, electrode data and designs and weld setups for welding individual parts plus illustrations and descriptions of typical applications. It also contains an engineering section on welding.

Electric Motor Valve Operators

Jamesbury Corp., Worcester, Mass. — Product data sheet, No. 6 in a series, provides technical information on the electric motor operators for application to all Jamesbury ball valves in the ¼ to 4-in. size range.

Corrosion Resistance Chart

OPW Corporation, 2735 Colerain Ave., Cincinnati 25, Ohio — A 4-page Corrosion Resistance Chart, J-CRC, lists over 150 different chemicals and their recommended usage with ductile iron, iron, steel, 316 and 304 stainless steel, monel brass, bronze, copper, aluminum and plastisol plastic.

A 4-page bulletin, No. F-31 RE, entitled "OPW Products for Liquid Fertilizers" describes and illustrates safety fill tank connection for liquid nitrogen solutions, Kamlok quick couplers, nozzles, strainers, Visi-Flo sight glass indicators, and swivel joints.

Fasteners and Rivets

Huck Manufacturing Co., 2480 Bellevue Ave., Detroit 7, Mich. — A 24-page, 2-color illustrated catalog describes the company's complete line of fasteners, and includes discussion of its tension and featherweight, self-broaching, and self-sizing fasteners; also pull-through blind, friction-lock, self-plugging blind, and lock-spindle self-plugging blind rivets.

. . . With ASAE Sections

(Continued from page 184)

by C. A. Reimer, agricultural research section, Dow Chemical Co. During the luncheon, A. E. Erickson, professor of soil science, Michigan State University, gave a travelogue of various fishing trips he has made entitled "The Pleasures and Satisfactions from Handling Slippery Projects."

A spring meeting is planned for May 6 at the Oliver plant in Battle Creek, featuring a technical program on systems of materials handling. National ASAE President L. H. Skrom will be present to discuss the subject from a manufacturer's point of view and will bring a message from headquarters at the banquet. A special feature for the ladies will be a tour of the Kellogg plant during the day. To complete the evening's entertainment a square dance is planned.

Mid-Central Section

The Mid-Central Section will hold its annual meeting on April 8 and 9 at the Hotel Robidoux, St. Joseph, Mo. Friday morning, April 8, will be registration time, and a student get-acquainted session is also scheduled for Friday a.m. The first of the technical sessions will be held on Friday afternoon at which time the following topics will be covered: "A Study of Farm Tractor Performance", "Practical Aspects of Pellet Handling Systems on Farms", "Some Effects of Cycling Temperatures on Swine", "Experimental Design for Cooling Sows During and After Farrowing", "Flow Problems of Feed and Grain", by D. F. Shimon, chief products engineer, Farm Equipment Division, Butler Manufacturing Co., and "Hydraulic Characteristics of Surface Irrigation". The attendants of the Section banquet on Friday evening will hear an address on the new look in farm mechanization package. The presentation of the winning student paper and awarding of the plaque, as well as presentation of the bowling trophies will be made at the banquet. A Student Section business meeting is also scheduled for Friday evening. The bowling contest, an annual affair, will be held on Friday afternoon.

The Section business meeting and election of officers will take place on Saturday morning. The concluding technical session also is scheduled for Saturday morning which will include panel discussions on minimum tillage research in the Mid-Central Section area, by W. Lovely, G. Fairbanks, J. S. McKibben, and H. D. Wittmus, and on factors that influence agricultural engineering enrollment in the Mid-Central Section area, by H. Beresford, G. H. Larson, M. M. Jones, and L. W. Hurlbut, as well as talks on operation of grain aeration systems, on lagoons for waste disposal in confinement rearing systems for swine, and on vegetated waterways for disposal of irrigation waste water and runoff from rainfall. The installation of officers on Saturday afternoon will close the two-day meeting.

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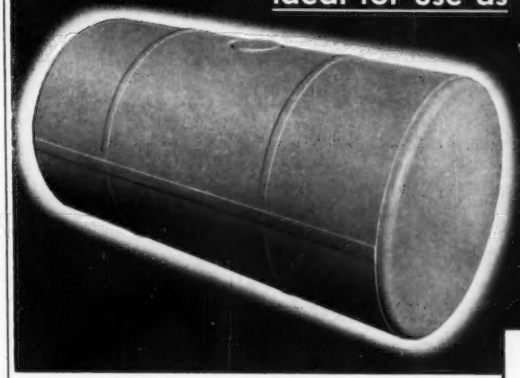
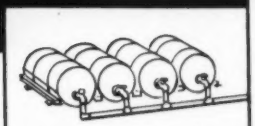
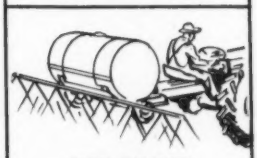
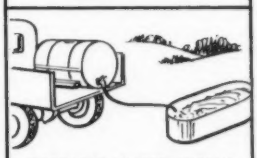




CHEMICAL STORAGE (CORROSIVE LIQUIDS)



FARM SPRAYER



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The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Aniansson, Gustaf J. A. — Agr. eng. res. engr., Swedish Institute of Agricultural Engineering, Uppsala 7, Sweden

Berlijn, Johan D. — Agr. engr., American-Sumatra Tobacco Corp., Quincy, Fla.

Buckner, Shelby S. — R. 2, Mars Hill, N. C.

Cafferty, Michael P. — Asst. des. engr., J. I. Case Co., S. Independence Ave., Rockford, Ill.

Candee, Russell — Chief product engr., John Deere Dubuque Tractor Works. (Mail) 975 Kirkwood, Dubuque, Iowa

Chapman, John A. — Jr. exec. trainee, Oliver Corp. (Mail) 511 N. Long St., Shelbyville, Ill.

Couch, Norman W. — District engr., The Torrington Co. (Mail) 1044 Hazel St., Birmingham, Mich.

Erdmann, Glenn C. — Chief engr., Allen Industrial Products, Inc. (affiliate of Stolper Steel Products Corp.) Menomonee Falls, Wis.

Farmer, Jack E. — Field engr., R. Fuller Co. (Mail) 3401 W. Diana, Phoenix, Ariz.

Fly, Claude L. — Asst. branch chief, Western Soil and Water Management Res. Branch, (SWCRD) (ARS), USDA. (Mail) 1604 Prospect Lane, Fort Collins, Colo.

Fouss, James L. — Agr. engr., Eastern Soil and Water Management Res. Branch, (SWCRD) (ARS), USDA, agr. eng. dept., The Ohio State University, Ives Hall, 2073 Neil Ave., Columbus 10, Ohio

Gardner, Jacob P. — Asst. chief engr., Allen Industrial Products, Inc. (affiliate of Stolper Steel Products Corp.). (Mail) W158 N9035 Charles Dr., Menomonee Falls, Wis.

Gerlach, Lloyd A. — Asst. to the pres., Allen Industrial Products, Inc. (affiliate of Stolper Steel Products Corp.). (Mail) 3280 Wetzel Lane, Brookfield, Wis.

Griffin, James H. — Settler assistance agent, Grant County Ext. Service. (Mail) 148 G St., S.E., Ephrata, Wash.

Hamilton, Ross S. — Service engr., John Deere & Co., Ltd. (Mail) Hanley, Sask., Canada

Hart, Roger Z. — Service mgr., West Machinery Co. (Mail) 2219 Hawthorn Ave., Kinston, N. C.

Henry, Calvin R.—Mgr., The Oliver Corp., Suite 223, Shoreham Bldg., 806 15th St., N.W., Washington 5, D. C.

Jones, Frank D., Jr. — Draftsman, John Deere Planter Works, 501 Third Ave., Moline, Ill.

Krause, David E. — Jr. des. engr., Rockford Works, J. I. Case Co., Independence Ave., Rockford, Ill.

Moriarty, Lloyd W. — Pres., L. O. Moriarty Lumber Co., Inc., Box 98, Argos, Ind.

O'Dell, Richard A. — Farm equipment engr., Butler Manufacturing Co., 7400 E. 13th St., Kansas City, Mo.

Overby, Charlie K. — Sales rep., New Holland Machine Co. (Mail) Box 326, Doraville, Ga.

Parker, Gene B. — Midwestern rep., Electricity-on-the-Farm Magazine, Suite 1210, 59 E. Van Buren St., Chicago 5, Ill.

Peterson, Kenneth R. — Jr. designer, John Deere Harvester Works, East Moline, Ill.

Powers, Harold C. — U.S. supervisor of field services (harvesting and tillage), Massey-Ferguson, Inc. (Mail) 11340 Dexter-Chelsea Rd., Chelsea, Mich.

Reimer, Charles A. — Field agriculturist, Agr. Res. Center, The Dow Chemical Co. (Mail) 2404 Belaire St., Midland, Mich.

Resetich, John M. — Eng. trainee, John Deere Harvester Works. (Mail) 509 16th St., Silvis, Ill.

Richardson, John P. — Analyst, Massey-Ferguson (Australia) Ltd. (Mail) 10 Benwerrin Rd., Mont Albert, Victoria, Australia

Ring, Peter J. — Student, University of New South Wales. (Mail) 6 Tycannah Rd., Northbridge, N.S.W., Australia

Rohweder, Glen W.—Eng trainee, John Deere Harvester Works. (Mail) 2629 10th St., Moline, Ill.

Tasker, Charles Thomas — Sales engr., Toledo Stamping & Mfg. Co. (Mail) 117 S. Wyman, Rockford, Ill.

Tedder, Geoffrey D. — Midwest sales engr. and asst. to chief engr., Howard Rotavator Co., Inc., Box 206, Harvard, Ill.

Thompson, James L., Jr. — Jr. des. product engr., J. I. Case Co., 407 S. Independence, Rockford, Ill.

Umstead, Willis C. — White Oak Rd., Garner, N. C.

Vincent, Richard F.—Proj. engr., Oscar Mayer & Co., 910 Mayer Ave., Madison 1, Wis.

Warfield, J. Gordon — Sr. eng. rep., rural power bur., Baltimore Gas and Electric Co., 1200 Lexington Bldg., Baltimore 3, Md.

Weaver, John C. — Special rep., American Dryer and Equipment Co., 2722 S. Hillock Ave., Chicago, Ill.

Welscher, J. N. — Special rep., John Wood Co. (Mail) 12 Ski Lane, North Oaks Farm, St. Paul 10, Minn.

Zoppi, Atillio J. — District sales mgr., Morse Chain Co., Div. of Borg-Warner Corp., 4868 N. Clark St., Chicago 40, Ill.

TRANSFER OF MEMBERSHIP

Anderson, James H. — Assoc. prof. and assoc. agr. engr., agr. eng. dept., Clemson College, Clemson, S. C. (Associate Member to Member)

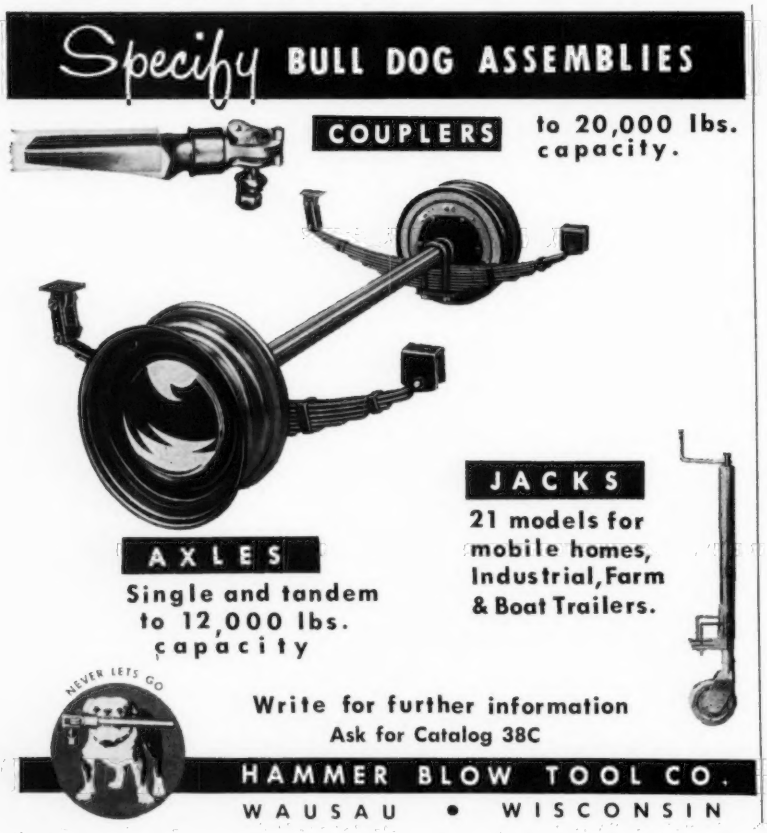
Bell, Eldridge S., Jr. — Assoc. prof., Virginia Agr. Exp. Station, agr. eng. dept., Virginia Polytechnic Institute, Blacksburg, Va. (Associate Member to Member)

Benfield, Philip L. — Sr. field rep., Douglas Fir Plywood Assn. (Mail) R.R. 1, Box 44, Pineville, N. C. (Associate Member to Member)

Berk, Martin A. — Des. engr., John Deere Spreader Works. (Mail) 606 15th St., Silvis, Ill. (Associate Member to Member)

Clendenin, Wilbur H. — Chief engr. in charge of product eng., grass tool section, Farm Equipment Res. and Eng. Center, International Harvester Co. (Mail) 4915 Pershing, Downers Grove, Ill. (Affiliate to Member)

Cornish, Harrison C. — Farm rep., Central Hudson Gas and Electric Corp., 607 Broadway, Kingston, N. Y. (Affiliate to Member)



Crawford, Todd V. — Asst. agr. engr., agr. eng. dept., University of California. (Mail) 521 Fourth St., Davis, Calif. (Affiliate to Associate Member)

Gawreluk, Demeter — Engr., J. I. Case Co. (Mail) 1633 Marlo, Davenport, Iowa (Associate Member to Member)

Hammett, Lyman R. — Rural engr., Virginia Electric and Power Co., Vepco St., Roanoke Rapids, N. C. (Associate Member to Member)

Henson, Wiley H., Jr. — Res. agr. engr., Farm Elecn. Res. Branch, AERD, (ARS) USDA, agr. eng. dept. North Carolina State College, P. O. Box 5906, Raleigh, N. C. (Associate Member to Member)

Lembke, Walter D. — Instructor, agr. eng. dept., Purdue University, Lafayette, Ind. (Associate Member to Member)

Mitchell, William G. — Agr. engr., Duke Power Co., Reidsville, N. C. (Associate Member to Member)

Norton, John S. — Assoc. prof., Cranberry Exp. Station, agr. eng. dept., University of Massachusetts, E. Wareham, Mass. (Associate Member to Member)

Overman, Charles L. — Power use dir., Tarheel Electric Membership Assn., Inc., P.O. Box 1699, Raleigh, N. C. (Associate Member to Member)

Peters, Leo C. — Engr., eng. res. div., John Deere Tractor Res. and Eng. Center. (Mail) 3603 Hillside Dr., Cedar Falls, Iowa (Associate Member to Member)

Pratt, George L. — Assoc. prof. and assoc. agr. eng., North Dakota Exp. Station, agr. eng. dept., North Dakota Agr. College, Fargo, N. D. (Associate Member to Member)

Shannon, William H. — Asst. chief engr. and product engr., Allis-Chalmers Mfg. Co., LaPorte, Ind. (Associate Member to Member)

Stout, Bill A. — Asst. prof., agr. eng. dept., Michigan State University, East Lansing, Mich. (Associate Member to Member)

Williams, Jack C.—Asst. to managing dir., American Concrete Pipe Assn. (Mail) 48 Brandywine Circle, Batavia, Ill. (Associate Member to Member)

Smith, Robert K. — Ext. spec., agr. ext. service, Mississippi State University, P.O. Box 1535, State College, Miss. (Affiliate to Associate Member)

STUDENT MEMBER TRANSFERS

Moore, Robert E. — (University of Arizona) Asst. engr., Watershed Div., Salt River Project, P.O. Box 1980, Phoenix, Ariz.

Robertson, Alan C. — (University of Idaho) 11 E. Chestnut #3, Walla Walla, Wash.

. . . Members in the News

(Continued from page 182)

A. Moayed Ghahremani, formerly manager of Farmers Mercantile Co., Watsonville, Calif., is now located in San Jose, Calif., with Farmland Irrigation Co., as sales manager.

John R. Barrett, Jr., has joined the Farm Electrification Research Branch of AERD, ARS, USDA. He is stationed at Lafayette, Ind., conducting research in cooperation with the Purdue University Agricultural Experiment Station. He recently received an M.S. degree in agricultural engineering from the University of Tennessee. While in Tennessee, he worked on plasma radiation of agricultural products.

Gordon H. Smith, who has been test engineer for Firestone Tire and Rubber Co. in Fort Stockton, Texas, advises that he has accepted a position of engineer with the Chandler Co.

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SAFETY DEVICES: low oil pressure cut-off switch for 2- and 4-cyl. engines, and high temperature safety switch for all models.

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Wisconsin's unique custom-engineered service provides these two reasons why:

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Second, for tougher re-design problems, its engineering counsel draws on more than 50 years of engine specialization to build the perfect partnership between your needs and time-tested features of Wisconsin reliability.

So, if you have a new engine-powered machine on your board, it will pay you to call Wisconsin in the early stages of planning. Send for Bulletin S-249 giving technical details on the complete heavy-duty air-cooled line — 3 to 56 hp. Write Dept. O-40.

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RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural-engineering interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

New Research Reports

Three new publications are available. The reports are based on studies of more efficient potato harvesters, planting sansevieria by machine, and using polyethylene covers to increase cotton plant emergence.

Authors of the report on potato harvesting are A. H. Glaves and G. W. French. R. E. Hellwig and M. H. Byrom prepared the report on sansevieria. E. R. Holekamp is author of the report on cotton. All are members of the Harvesting and Farm Processing Research Branch, AERD, ARS, USDA.

Agriculture Handbook 171, "Increasing Potato-Harvester Efficiency"; and ARS 42-34, "Sansevieria Planting Machinery," will be sent by the Information Division, ARS, USDA, Washington 25, D. C.

Request Progress Report 2113, "Cotton Emergence Increased with Polyethylene Covers," from the Texas Agricultural Experiment Station, College Station.

Cotton Defoliation Cited

Defoliation of cotton plants to reduce moisture on the lint before harvest in humid areas is important in preserving the quality of fiber, a recent Mississippi technical bulletin points out. It also indicates that defoliation can increase the number of safe picking hours.

Authors of the bulletin are J. A. Riley, research agricultural meteorologist of the U. S. Weather Bureau, and E. B. Williamson, agricultural engineer of the Cotton Harvesting Section, Harvesting and Farm Processing Research Branch, AERD, ARS, USDA. Their research was conducted at the Delta Branch Experiment Station, Stoneville, Miss., in cooperation with the Mississippi Agricultural Experiment Station.

They found that leaf cover is one of the major influences on amount and duration of moisture in cotton fields. Previous investigations showed that excess moisture complicates handling, cleaning, and ginning of seed cotton. Other tests revealed that atmospheric moisture greatly influences the moisture content of machine-picked seed cotton.

Copies of the report are available from the Mississippi Agricultural Experiment Station at State College. Request Bulletin 581, July 1959, "Relative Humidity in Cotton Fields at Harvest Time."

Measures Efficiency of Tillage Methods

A way to measure the relative efficiency of tillage methods has been developed by agricultural engineers of the U. S. National Tillage Machinery Laboratory, Auburn, Ala.

Blocks of soil are dropped varying distances to impart different amounts of energy to the soil. This energy is related to resulting mean clod size.

Relative tillage method efficiency is determined by comparing the energy required by each method with the crop energy that produces the same mean clod size.

Reprints Available

Reprints of three reports taken from Volume 18, 1958, of the proceedings of The Soil and Crop Science Society of Florida are available. Subjects discussed are harvesting and processing equipment for kenaf, harvesting and decorticating sansevieria, and mechanization of brush fiber production.

Hiram D. Whittemore and Robert E. Hellwig are authors of the report on kenaf. Mr. Hellwig and Mills H. Byrom prepared the report on sansevieria. Mr. Byrom and Mr. Whittemore wrote the report on brush fiber production. They are members of the Long Vegetable Fiber Plants Section, Harvesting and Farm Processing Research Branch, AERD, ARS, USDA, Belle Glade, Fla. The studies of kenaf and sansevieria were conducted with cooperation of the Florida Agricultural Experiment Station.

The reprints will be sent on request by the Harvesting and Farm Processing Research Branch, AERD, Room 326, North Building, USDA Plant Industry Station, Beltsville, Md.

Soil Compaction Bibliography

An Annotated Bibliography on Soil Compaction consisting of over 600 references with a short description of each reference and complete with subject index has been published by the American Society of Agricultural Engineers. The publication is a contribution of the Bibliography Subcommittee of the Soil Compaction Committee of ASAE, with representation from the Soil Science Society of America. Copies are available at $1.50 each ($1.00 to ASAE members). Quantity price for 25 copies or more is $1.00 each. Orders with remittance may be sent to ASAE, 420 Main St., St. Joseph, Mich.

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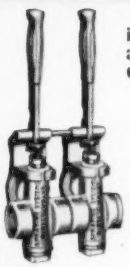

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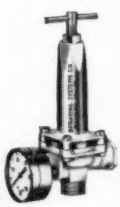

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Diaphragm Pressure Relief Valve —write for Bulletin 101.

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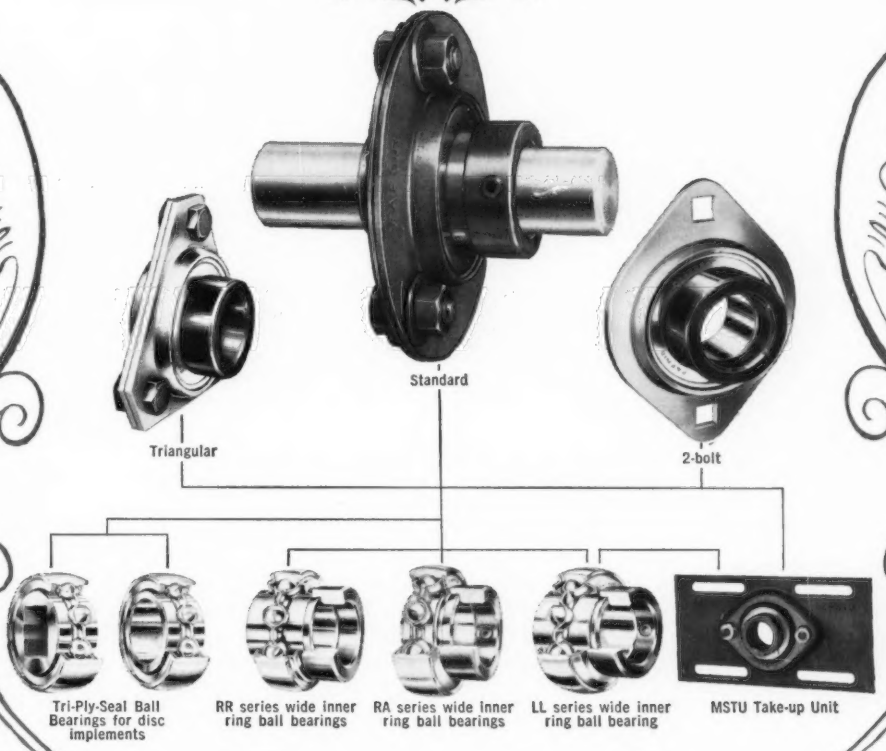
Standard
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Tri-Ply-Seal Ball Bearings for disc implements
RR series wide inner ring ball bearings
RA series wide inner ring ball bearings
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MSTU Take-up Unit

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PERSONNEL SERVICE BULLETIN

Note: In this bulletin the following listings current and previously reported are not repeated in detail. For further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this bulletin, request form for Personnel Service listing.

Positions Open (1959) — November — 353-969, 360-970, 358-972, 361-973. **December** — O-378-974, 384-975, 386-976, 387-977, 370-980, 394-981, 404-982. **(1960) — January** — O-395-983, 395-984, 441-985, 452-986. **February** —O-4-601, 11-602, 22-603, 35-605.

Positions Wanted (1959) — November — W-343-55, 363-57. **December** — W-390-59, 388-60. **(1960) January** — W-411-61, 426-62, 427-63, 433-64. **February** — W-3-1, 10-2, 15-3, 16-4, 17-5, 5-6, 33-8, 37-9, 30-10.

NEW POSITIONS OPEN

Field Representative for trade association, to handle educational and promotional work primarily in farm structures, through colleges, extension specialists, vocational agriculture leaders, farm managers, and farm and distributor exhibits. Midwest location. Age 25-35. Agricultural college degree, preferably with specialized training in farm structures. Farm background desirable. Experience in sales or promotional work in farm field helpful. Usual personal qualifications for sales or promotional work. Considerable travel necessary. Good opportunity for advancement. Salary open. O-55-606

Chief Engineer for farm equipment division of established manufacturer. Upper Midwest. Age 35-45. Degree in engineering. Equipment design experience 5 years, preferably in farm implement field. Management work 2-5 years. Able to get along well with people. Excellent opportunity with fast growing organization in both farm and industrial machinery fields. Salary open. O-56-607

Agricultural Engineer for research in rural electrification and processing with emphasis on power utilization, with midwestern state university. Age, under 35. BS and preferably MS degree in agricultural engineering, or equivalent. Opportunity for continuing work for advanced degree. Some research experience desirable. Interest and potential for productive research. Salary open. O-57-608

Graduate Assistants (3) for half-time work in feed handling for dairy cattle, feeding equipment for beef cattle, and grain drying and storage. State college in upper Midwest. BSAE or equivalent, with grades acceptable for admission to graduate school. Genuine desire for graduate work. Graduate credit rate about 10 credits per quarter. Excellent facilities for graduate work under guidance of competent staff members. Positions available on or before Sept. 1, 1960. Two weeks paid vacation. Salary $2400 plus incidental fees. O-66-609

Field Promotion Representatives (7) for building material trade association. Promotion through calls on volume construction specifiers including architects, engineers, builders, large industrial users, retail lumber dealers, and jobbers. Also contact building code and governmental agencies. Current openings in 7 centers in East and Midwest. Men will generally be hired for locations nearest to present residence. Age 27-37. BS in agricultural or civil engineering, industrial design, or forest products, or substantial equivalent in technical understanding and knowledge of structural engineering. Several years experience with emphasis on structures. Neat appearance, good character, able in both oral and written self expression. Genuine interest and potential for honest, aggressive promotion of high quality product. Opportunity for advancement in field department and in fast growing industry up to individual. Salary open. O-83-610

Development Engineer for work on improvement and replacement parts and accessories for farm tractors implements and machinery, from inception through manufacture. Midwest. Age, preferably under 30. BSAE or BSME. Farm background. Multi-crop experience with tractors, combines, corn pickers, hay and forage helpful. Knowledge of metal manufacturing techniques desirable. Want thorough, precise man, able to complete projects. No limit to opportunity. Salary open. O-21-611

NEW POSITIONS WANTED

Agricultural Engineer for development, research, sales, or service, soil and water field, with industry or public service. Southeast or foreign service. Married. Age 24. No disability. BSAE, 1959, MSAE expected June 1960, Louisiana State University. Farm background. Commercial diver 3 years. Research assistant during graduate study. Available June 1960. Salary open. W-46-11

Agricultural Engineer for development or sales in power and machinery or rural electric field with manufacturer or distributor in East or South. Limited travel. Married. Age 27. No disability. BSAE, 1955, Pennsylvania State University. Soil Conservation Service 1½ years. U. S. Navy commissioned service (aerial navigation) 3½ years. Available May 1, 1960. Salary open. W-63-13

Agricultural Engineer for extension, teaching, or research, soil and water field, with public service agency, preferably in Southwest. Married. Age 40. No disability. BSAE, 1942, Kansas State University. Graduate study 15 credit hours, Colorado State University. Soil Conservation Service, civil enginer, 2 years. Research engineer 7 years, Agricultural Research Service. Operator-manager of 1600-acre irrigated farm 5 years. Enlisted and commissioned war service 3 years 8 months. Available on reasonable notice. Salary $7000. W-62-14

Agricultural Engineer for development, research or teaching with manufacturer, processor, or public service agency in East. Limited travel. Single. Age 31. No disability. BSAE, 1954, Pennsylvania State University. MSAE expected June 1960, University of Massachusetts. Public service teaching and research 4½ years. Enlisted and commissioned service in Navy, 3 years. Available July 1, 1960. W-77-15

Agricultural Engineer for design, development, or research in power and machinery or product processing, with manufacturer. Any location, South preferred. Limited travel. Married. Age 22. No disability. BSAE, 1959, Southwestern Louisiana Institute. MSAE expected August 1960, Louisiana State University. Farm background. Experience as assistant laboratory instructor in agricultural engineering, and student helper in college creamery. Available September 1, 1960. Salary open. W-69-16

Agricultural Engineer for design, development, or service in power and machinery, with manufacturer, preferably in Midwest. Single. Age 30. No disability. BSA and BSME, 1959, University of Wisconsin. Aircraft and engine mechanic, AFUS, 2 years. Miscellaneous other work experience. Military service over 3 years. Available on reasonable notice. Salary open. W-75-17

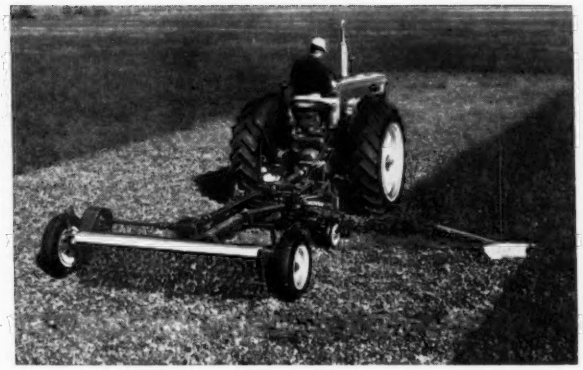
Agricultural Engineer for extension, teaching, or research in soil and water field, with public service. Any location. Married. Age 23. No disability. BSAE, 1959; MSAE expected June 1960, University of Missouri. Experience in civil engineering one summer. Graduate assistant in teaching and research one year. Interested in work toward PhD. Available June 15, 1960. Salary $5,000+. W-73-18.

Agricultural Engineer for extension, teaching, research, writing, or management in farm structures or electric power and processing field with public service or industry, preferably in eastern Canada or northeast U.S.A. Married. Age 35. No disability. BSA, Ontario Agricultural College, 1949. MSAE Cornell University, 1960. Farm background. Power company experience as farm service advisor and in management and construction. Currently assistant area manager. Available April 1. Salary open. W-74-19.

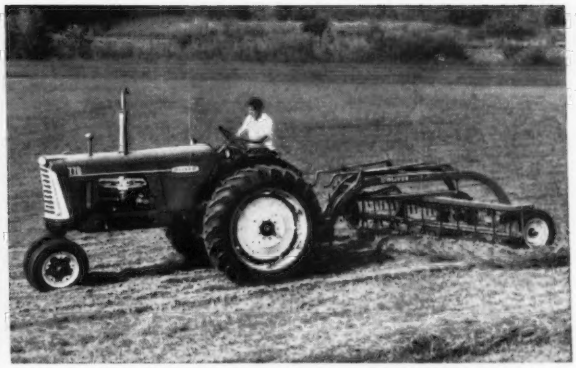
Agricultural Engineer for extension, teaching, or research in soil and water field with public service agency in Northwest, Southwest, or Midwest. Prefer location within commuting distance of a state university or college. Married. Age 33. No disability. BSAE, 1951, Texas A & M College. Manager of retail farm machinery business one year. Agricultural engineer in conservation work with Bureau of Indian Affairs, 7 years. Available on 45 days notice. W-76-20

Agricultural Engineer for design, development, research, extension, or service in power and machinery or materials handling, with industry or federal agency. Any location. Prefer eastern U. S. Single. Age 21. No disability. BSAE, University of Maine, expected in June 1960. Experience in maintenance and operation of machinery on state experiment farm. Some building experience. Available June 1. Salary open. W-94-21.

Agricultural Engineer for design, development, research, extension or sales in rural electric, product processing, or soil and water field, with experiment station, federal agency, distributor or farming operation. Any location. Prefer South. Married. Age 23. No disability. BSAE, January 1960, Texas A. & M. College. Farm background. Four summers in construction work. Available on reasonable notice. Salary $300 per month. W-78-12.



REDUCE CURING TIME 50%—You mow and condition in one trip over the field...reduce bleaching and rain spoilage.



FAST, GENTLE RAKING—Here's your high-speed quality-saver. Parallel bars sweep sideways, and save the high-protein leaves.

OLIVER'S 12-TON SYSTEM

wins the race for quality forage

12-TON-PER-HOUR BALING—Saves time, saves quality, wins the race against weather hazards. You get the best hay and the best bales when you switch to the new OLIVER Model 62.

Quality and Capacity Assurance

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- Smooth, roller-chain, oil-bath drive

No. 95 Conditioner

- Direct-line PTO hookup to mower
- Large-diameter, corrugated rolls
- Safe V-belt drive, spring tension rolls

No. 107 Rake

- Semi-mounted, ground-driven
- Gentle, 5-bar, sweep-action reel
- Handy hydraulic basket lift

NEW! Model 62 Baler

- Roto-Flo feed
- Uniform bales, 12 tons per hour, wire- or twine-tie
- Leaf-tight construction, positive knotting

GET SET and GO—go for hay quality at modern tractor speeds. See your nearby Oliver dealer and get a trial of this 12-ton-per-hour forage system in your own field. See how you mow, condition, rake and bale a steady 12 tons with positive leaf-saving action...how you beat the weather hazards and get your crop in while quality is high. Notice how the gentle action of these four high-speed Olivers takes care of the high-protein leaves.

While you're talking with your Oliver dealer, why not ask for a TEAMED-POWER demonstration—a high-efficiency Oliver tractor matched with one of the four quality-saving hay tools. Then see how much more quality forage you'll bring in. Remember, too, early trade-ins for Oliver tractors and balers are eligible for a 6% bonus on your down payment until delivery time.

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Index to Advertisers

Acme Chain Corp. 191
Aetna Ball & Roller Bearing Co. 141
Aluminum Company of America 185
Armco Drainage & Metal Products, Inc. 144
Automotive Gear Div., Eaton Mfg. Co. 132
Borg-Warner Corp. 138, 139
Bower Roller Bearing Div., Federal-Mogul-Bower Bearings, Inc. 137
Chain Belt Co. 131
Cleveland Graphite Bronze, Div. of Clevite Corp. 187
Dana Corporation 181
Dayton Industrial Products Co., Div. of The Dayton Rubber Co. 142, 143
Deere & Company 146, 147
Deniston Company 190
Electric Wheel Co., Div. of The Firestone Tire & Rubber Co. 198
Fafnir Bearing Co. 197
Federal-Mogul Div., Federal-Mogul Bower Bearings, Inc. 135
Hammer Blow Tool Co. 194
Industrial Instruments, Inc. 188
International Harvester Co. 133
Lincoln Engineering Co., Div. of The McNeil Machine & Eng. Co. 150
Link-Belt Co. 3rd Cover
Locke Steel Chain Co. 200
Molded Fiber Glass Body Co. 193
National Rain Bird Sales & Eng. Corp. 192
National Seal Div., Federal-Mogul-Bower Bearings, Inc. 151
Neapco Products, Inc. 140
New Departure, Div. General Motors Corp. 2nd Cover
Oliver Corp. 199
Perfect Circle Corp. 152
Portland Cement Assn. 183
Rockford Clutch Div., Borg-Warner Corp. 189
Rockwell-Standard Corp., Universal Joint Div. 129
Ross Gear and Tool Co., Inc. 148
Spraying Systems Co. 196
Timken Roller Bearing Co. 4th Cover
Triangle Mfg. Co. 192
Twin Disc Clutch Co. 149
Warner Automotive and Wooster Div., Borg-Warner Corp. 145
Wisconsin Motor Corp. 195

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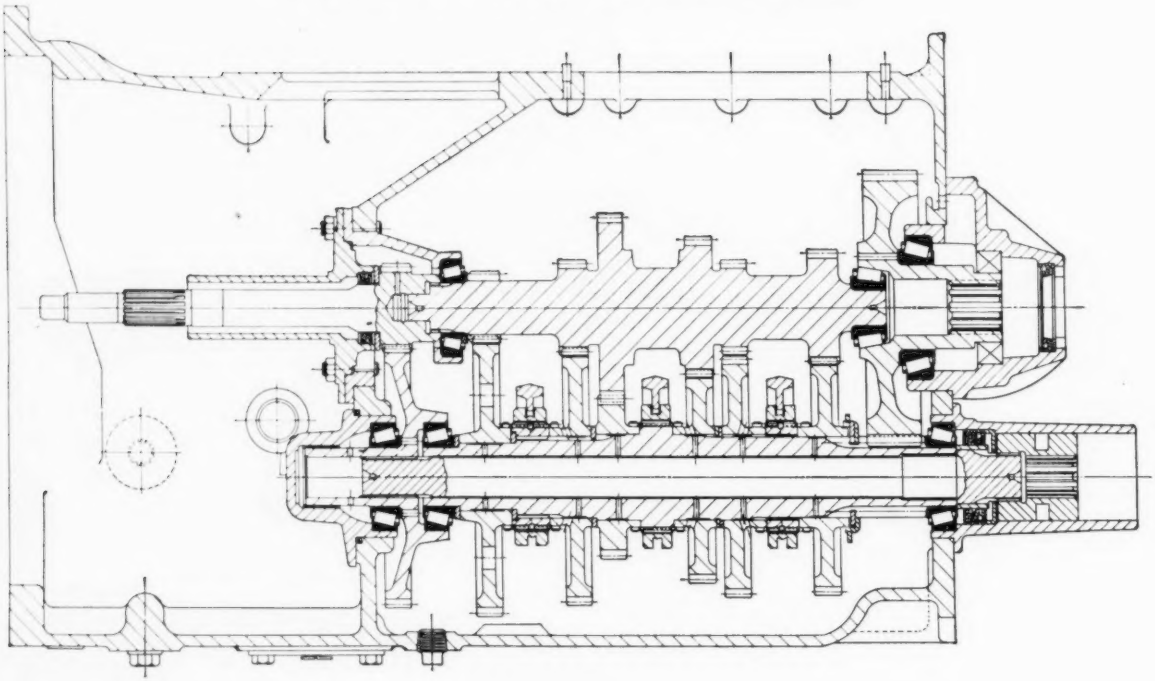
Ford 5-speed tractor transmission uses tapered roller bearings for gear rigidity, compact design

Tapered design permits optimum bearing adjustment, better load distribution



WHEN Ford Motor Company engineers designed the tractor transmission shown in the layout above, they took full advantage of the special mounting and operating characteristics and benefits of tapered roller bearings. Tapered roller bearings are used in the main shaft front and rear, countershaft front and rear, inner output gear and PTO gear.

Tapered roller bearings permit optimum bearing adjustment. Assuring rigidity and positive alignment of gears and shafts. Loads are distributed better. Gear life is increased. And the space-saving bearings permit extremely compact design.

Timken® tapered roller bearings give farm equipment greater rigidity and longer life because their tapered design enables them to take radial and thrust loads in any combination. Full-line contact and rib-guided rollers combine to pack more capacity in less space, simplify designs, cut costs. By keeping shafts concentric with their housings, Timken bearings make closures more effective in keeping lubricant in, dirt out. And because Timken bearings practically eliminate friction they save power and fuel.

Timken tapered roller bearings answer three big problems for agricultural engineers—combination loads, dirt, and ease of operation. And Timken Company Sales Engineers have the experience and testing facilities that mean service you can't get anywhere else. Call or write today. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.*

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